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RAPPORTS ET PROCÈS-VERBAUX DES RÉUNIONS

Volume 147

Contributions to Special Scientific Meeting
and to
Joint Meeting of the Baltic-Belt Seas and the Salmon and Trout Committees 1957

Measures for Improving the Stock of Demersal Fish in the Baltic

En Commission chez

ANDR. FRED. HØST & FILS

COPENHAGUE

Prix: Kr. 20.00

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Table of Contents

Page

Introduction, by *W. Cieglewicz* 5

Special scientific meeting on measures for improving the stock of demersal fish in the Baltic. Summary of papers and discussion, by *Aage J. C. Jensen* 6

1. Danish investigations on the stocks of cod, plaice, flounder, and dab in the central Baltic and the fishery for these species in the western Baltic, by *Aage J. C. Jensen* ... 14
2. On the stock of flatfish and cod and the yields of the German fishery in the Baltic, by *R. Kändler* and *Fr. Thurow* 24
3. The state of the south Baltic flatfish stock, by *Z. Mulicki* 39
4. The state of the stock of cod in the southern Baltic as indicated by Polish investigations, by *St. Rutkowicz* 48
5. Some comments on statistics relating to Swedish fisheries in the Baltic, by *Sven Sahlin* 56
6. Swedish cod investigations in the Baltic, by *G. Otterlind* 65
7. Some data on the life history and fishery of cod in the central Baltic, by *T. F. Dementjeva* 68
8. Characteristics of the fishing stock of flounder in the central Baltic, by *K. A. Zemskaya* 73
9. Selection of Baltic cod by cod-ends of different materials, by *W. Cieglewicz* and *W. Strzyzewski* 75

Joint meeting of the Baltic-Belt Seas Committee and the Salmon and Trout Committee to discuss salmon problems of the Baltic. Summary of discussions, by *Aage J. C. Jensen* 81

10. Principles for the protection of salmonid fish in the Baltic, by *F. Chrzan* 83
11. Notes regarding the salmon fishery in the Baltic during recent years, by *Gunnar Alm.* 87
12. Results of salmon smolt tagging in the Baltic area, by *Börje Carlin* 89

Map showing the area under discussion.

INTRODUCTION

Technical development of the fishing fleets on the high intensity of exploitation of the demersal fish stocks in the Baltic have recently reached such high levels that anxiety is felt about the future of those resources and the economy of the Baltic fisheries generally.

The desirability of a new Convention for the protection of the fish stocks in the Baltic had already been discussed in 1953 and supported by the members of the Baltic-Belt Seas Committee. Papers by *J. Knudsen* (1954), *R. Kändler* (1954), *A. R. Molander* (1954), and *Aa. J. C. Jensen* (1955) provided subjects for further discussions of this problem during the next meetings of the Baltic Committee. These authors gave evidence for concluding that the population of demersal fish in the Baltic was declining.

During the meeting of the Baltic-Belt Seas Committee in 1954 it was agreed that a thorough working up of all the available data was necessary to prepare a statement of the scientific background of the measures recommended. The Council adopted the recommendation of the Baltic-Belt Seas Committee that a special scientific meeting should be organized dealing with "Measures for improving the stock of demersal fish in the Baltic". This meeting took place in Bergen in connexion with the 45th statutory meeting of the International Council for the Exploration of the Sea in 1957.

As Convener of this meeting I have pleasure in expressing my thanks to all contributors and to all who participated in the discussion, as well as to Dr. *Aa. J. C. Jensen*, who acted as Reporter during the meeting.

The contributions and the discussion gave rise to an important recommendation to be forwarded through the Council. It is hoped that this recommendation will contribute to an agreement between the Governments of the countries bordering the Baltic for the purpose of protecting and improving the stock of demersal fish in the Baltic.

W. Cieglewicz

Special Scientific Meeting on Measures for Improving the Stock of Demersal Fish in the Baltic

Convener: Professor W. Cieglewicz; Rapporteur: Dr. Aage J. C. Jensen

The meeting was held on 29. September 1957 at Bergen

Participants:—

Denmark:
O. Bagge
Aa. J. C. Jensen
K. Popp Madsen

Finland:
E. Halme
I. Hela
V. Sjöblom

Germany:
R. Kändler

Norway:
G. Dannevig
A. Hylen

Poland:
W. Cieglewicz
F. Chrzan
K. Demel
W. Mańkowsky
S. Zarnecki

Sweden:
G. Alm
B. Carlin
A. Lindroth
G. Otterlind

U.S.S.R.:
G. Nikolsky

Summary of Papers and Discussion

The summary is not exhaustive but special attention has been paid to information relating to the necessity and best methods for the protection of the stocks. Other information to be found in this volume deals with the relationship between girth and length, selection of the fish by different mesh sizes, and the variation of the yield from the various countries.

Fishing Methods

The most important gear employed for demersal fish in the Baltic is the trawl. Nets and hooks are used in coastal waters and these take a relatively large part of the catches of demersal fish in the western Baltic. In the Baltic, hooks are also used for cod on some banks in the open sea. Pound nets and traps are used in the western Baltic and the westernmost parts of the Baltic proper, mainly for cod, but some flounders and plaice are also taken.

The trawls operated by Denmark are almost exclusively made of cotton twine, whereas in other countries hemp and manila is also used. In recent years bobbins of 10—15 cm have been used regularly in the central Baltic and the fishery now extends to the rougher ground.

Vessels fishing with trawls are mostly of the cutter type. Until about 10 years ago few vessels were more than 35 BRT, which class is still the most numerous. The larger vessels have engines of 60 to 70 h.p.; a few from 100 to 150 h.p. and the horse-power is gradually increasing. In recent years an increasing number of cutters of 60 to 100 BRT with engines of 150 to 200 h.p. are being employed, especially from eastern Baltic countries.

In the western Baltic, Danish seines and trawls were introduced about 1912 and in the Baltic proper in the 1920's. They were at first used mainly for flatfish but later mostly for cod. Danish seines, which were used mainly from Denmark in the early days of the fishery, have now almost totally disappeared from the Danish

fishery in the Baltic proper, but some are used from Sweden (Sahlin, this volume).

The trawl fishery as a whole has increased over the years. Development was interrupted during the last war when the cutter fishery was restricted, but German North Sea trawlers carried on a very intensive cod fishery.

The catch from all Baltic countries has not been shown in the *Bulletin Statistique* since 1913. It may be estimated that the total annual catch of demersal fish in the beginning of the 1930's was about 35 mill. kg and at the end of this period it was about 45—55 mill. kg. In 1939 the catches rose when the German steam trawlers were transferred to the Baltic, and in 1940 it may be estimated at 85—90 mill. kg but in the first years after the war it rose again, and in 1949 it seems to have reached more or less the same amount as in 1940. Then it appears to have decreased again but in recent years it has increased very much. In 1954, figures for the catches of Poland and the USSR were published in the *Bulletin Statistique* for the first time after the war, and in that year the total catch of demersal fish from all member countries of ICES was 170 mill. kg, i.e., about double the total catch in 1940 and 1949. In 1956 the total catch of demersal fish in the Baltic registered in the *Bulletin Statistique* was 210 mill. kg. The investigations have proved that this rise is due to an enormous increase in the fishing activity, and this situation is a most serious background for the papers in this volume.

Biology and Fishery of each Species

Cod

Integrity of the stock

The stock of cod in the western Baltic must be influenced by eggs and larvae born on the currents from the Belts, but the stock of older cod seems to be mostly stationary in the westernmost part of the western Baltic and the southern Little Belt. In the Baltic proper the stock seems to be almost self-supporting (Jensen, this volume). The migrations of cod in the Baltic proper are of great importance in these deliberations as to how far a subdivision of the area for protective measures is justified. According to Otterlind, migrations occur between the southern and the northern Baltic, where eggs or fry do not seem to survive. Rutkowicz has mostly east-to-west migrations, and long migrations are relatively few. Danish marking experiments have shown mostly irregular migrations in all directions from the Bornholm Deep.

Fluctuations in the density of the stock

The density of the stock of cod increased greatly in the 1930's and later it fluctuated about a much higher level than before. Alander (1946) found that the rise of a strong year-class was due to strong inflows of saline water in the previous months, and Dementjeva (this volume), has clearly shown the parallelism of the inflows of saline water and the size of the stock.

The *annual growth* in the western Baltic is about the same as in the Belts, about 14 cm in the first two years and then decreasing to about 7 cm in the fifth year. In the Bornholm region it is about 10 cm a year in the first five years (Rutkowicz, this volume). In the Gothland Deep according to Kändler (1954) and Tokareva (Dementjeva, this volume) it is about the same in the first four years but afterwards becomes less. Kändler (1954) has also found that growth in the Gothland Deep is a little less than in the Arkona Deep.

All authors agree about the growth-rate in recent years but there is disagreement about the growth-rate in earlier years. According to Danish investigations a small improvement in growth-rate has been found in the Bornholm region since the 1920's and 1930's, whereas Kändler (1954) and Dementjeva (this volume) have found a decrease in growth-rate since the end of the latter period. It must be admitted that the age of the cod is difficult to read from the otoliths and in particular the first year's growth may be overestimated, but it may be very small because some cod in the Baltic proper spawn late in summer, and the limit between the age-groups is put at April when the yearly growth season normally starts. Biologically, a change in the growth-rate may be of importance. The most likely cause of the decrease in growth-rate is the stronger competition for food in the denser stock of later years (Dementjeva, this volume). A more intensive fishery might also improve the growth-rate and the quality of the fish.

That an intensive fishery influences the length composition of the stock of cod is suggested from the changes which took place during the war (Jensen, 1954). The fact that the fishery intensity influenced the density and length composition of the catches in the following years has been shown by Rutkowicz (this volume).

The growth-rate is closely related to the quality or nutrition coefficient of the fish and if the growth-rate in former years was higher than now, it must have been accompanied by a better quality than now. Determination of the nutrition coefficient before the increase of the density of the stock does not appear to have been carried out but complaints that lean cod were sometimes found in some parts or other of the Baltic proper in some of those years seem to indicate that the nutrition coefficient has not been very much different from that of recent years.

The nutrition coefficient in the western Baltic

seems to be about the same as in the Belts or the Kattegat, and it is always very satisfactory. In the Baltic proper the coefficient at Bornholm is generally about 1 but sometimes lean cod with a lower coefficient may occur (Jensen, this volume) and the occurrence of lean cod seems to be a more common feature in the more easterly parts of the central Baltic (Meyer, 1952).

Mortality rates and calculated change in yield

The reduction in the numbers of a year-class from one year to the next is about the same in the western Baltic as in the Belts. It was about 78 % a year in the 1927 to 1932 year-classes (Jensen, 1939). It may be assumed that each of the components, natural mortality and fishing mortality, is about the same as in the Belts. The total annual reduction of cod between age-groups I and III at Bornholm was approximately 50 % (44—58 % in the different periods of years from 1925—57). This is nearly the same as found for the Belt Sea in 1919—38. The total annual reduction between age-groups III and VII was 45 % in 1925—35 and 76—79 % in 1935—39 and 1951—56 (Jensen, this volume). The yearly reduction after 1935 is almost as high as in the Belts and the Kattegat.

From the paper of Dementjeva (this volume) the yearly reduction in the central Baltic can be calculated from the relative density of the age-groups found by multiplying the percentage age composition in the main spawning period in Table 4 by the average catch per hour in the same season. It was as follows in 1948 to 1956:—

IV/V	V/VI	VI/VII	VII/VIII	VIII/IX	V/IX	Average for all groups
45 %	64 %	51 %	71 %	66 %	60 %	63 %

Rutkowicz (this volume) has found that the total mortality between age-groups III and IV increased from 30 % a year between 1948 and 1951 to 48 % in the period 1955/56, and stresses that this increase in mortality must be due to a more intensive exploitation of the smaller fish which accentuates the necessity for protective measures. Dementjeva (1957) has also pointed out that a fishery for young cod, 25—30 cm in length, has developed in recent years on the feeding grounds, and that therefore rationalization of the fishery for young cod is urgently needed in order to increase the weight of the catch. Knudsen (1954) has stressed that the present large stock of cod in the Baltic is due to an amelioration of the climate, and if more unfavourable climatic conditions return the stock will decrease and protective measures will become even more necessary.

The figures found for the reduction of the age-groups younger than 3 years may be larger than the real total mortality rate in the stock because they may be influenced by migrations, but no doubt they are mostly due to natural mortality. Fishing for small cod has been carried out from some countries and must have contributed to the great mortality rates.

For the older age-groups we may assume that the annual natural mortality is greater than in the western Baltic and in the Belts, because the nutrition conditions are poorer.

The change in the catch per unit of fishing effort can be calculated on the basis of age composition of the commercial catches, the growth-rate and the annual reduction of the number of an age-group. Such calculations show that the Danish catch per effort would increase about 50 % if the size limit was raised by 10 cm (from 33 cm to 43 cm) on the assumption that the annual natural mortality is 30 %. This is probably higher than the upper limit of the possible value of the natural mortality. If it is assumed to be 20 % the Danish catch per fishing unit would increase about 60 % (Jensen, this volume). On the basis of the figures given in the present paper by Dementjeva, it is found that the USSR catch per fishing effort on the spawning grounds would increase by about 50 % by increasing the size limit by 10 cm if the natural mortality is 20 % a year.

Fishery

The cod fishery in the Baltic is carried out mainly by trawl, other gears being far less important except for those fisheries in coastal areas.

In the western Baltic, the Danish and German catch increased in the 1940's a little later than the increase of the stock, but after 1950 it has shown a small tendency to decrease, although the fishing intensity appears to have remained unchanged during recent years.

In the Baltic proper the total yield increased during the 1930's, a little late in comparison with the rise in the density of the stock. In the years 1940 to 1944 the total catch was very much higher on account of the intensified German fishery by steam trawlers (Meyer, 1952) but during these years a decrease in quantity per effort and also of the size of the cod took place, due, no doubt, to the intensive fishery (Jensen, 1954). After the war the catch from some countries has fluctuated at about the same, or perhaps a little higher level than during the war; in other countries, apart from some fluctuations due to changes in the density of the stock, the catch has increased, and in 1955/56 it was about double that in 1940/46. In 1955 the total catch in the Baltic proper from all ICES' member countries was 114 mill. kg, i.e., the same as the highest annual catch in the North Sea (118 mill. kg

n 1921). In 1956 it has increased to 147 mill. kg. The Polish and USSR fisheries have shown a very great ise in recent years. In 1955 they took 67 % of the to-al weight of cod from the Baltic proper, in 1956 6 %. The increase must be due partly to a temporary mprovement of the stock from the two rich 1953 and 954 year-classes, but mainly to the increased fishing. The differences between the strength of the year-lasses are very much larger in the Baltic than in the North Sea, and therefore the rich year-classes give ise to great fluctuations in the catch per fishing ef-ort and in the total yield. A temporary increase of he catch per fishing effort must not allow to over-ook the fact that the changes in the age and size omposition of the stock clearly show that it is being verfished and that protective measures will give an ncrease of the catch per effort.

It is well known that the stock of cod in the North ea is overfished. The stock in the Baltic is no doubt maller than that in the North Sea and, on account f the slower growth-rate and the greater natural nortality, it is very much more exposed to overfish-ng, to such a degree in fact, that the catch per fish-ng effort becomes very much less than the optimal ield, and so the need for international protective neasures is urgent.

Plaice

Biology

The stock of plaice in the western Baltic is part of he Belt Sea stock. In the Baltic proper, plaice is only f commercial importance up to around Bornholm. The stock in the westernmost part of the Baltic pro-er, the Møen region, is mainly a part of the stock pawning in the Baltic proper but some years it is nfluenced by inflows of eggs and larvae through the Sound and from the western Baltic. Immigrations of lder plaice to the Møen region occur from the Sound where the stock contains relatively many more large and old fish than, for example, in the Belts, because rawling and seining are prohibited in the Sound. Plaice in this westernmost part of the Baltic proper nay therefore be older and larger than what might otherwise be expected.

The stock of plaice in the Bornholm region is self-dependent as shown by the investigations of A. C. Jo-hansen. Marking experiments are few in the Baltic proper but in the Bornholm region most of the migra-ions seem to be undertaken annually from the feeding grounds in less than 50 m depth to the spawning grounds in more than 50 m.

The growth-rate of the plaice in the western Baltic s about the same as in the Belts. In the Møen and Bornholm regions it is nearly the same as in the Belts n the first two or three years but it then becomes slightly slower. The growth-rate has improved very much in the whole Baltic (Kändler, 1954; Molander, 1955), parallel to the reduction of the stock due to the more intensive fishery which started about 1912 in the western Baltic and about 1920 in the Bornholm region.

The nutrition coefficient in the western Baltic and its annual winter/spring minimum is the same as in the Belts because the spawning time (January/February) is approximately the same (Kändler and Thurow, this volume) and this applies in all essentials to the Møen region. In the Bornholm region the annual minimum lasts a little longer and comes a little later because there the main spawning season is in March/April. In late summer the quality is usually just as good as in the western Baltic or the Belts (Jensen, Mulicki, this volume).

Prices are very much influenced by quality, and when landings of mature or spent females are allowed the price is very low for all plaice because the poor quality of the females brings plaice into bad repute. In Denmark the prohibition of the landing of female plaice, when the gonad extends over half of the fish's length, in some winter months will keep the prices near to the annual mean, but at Bornholm the close season is mainly before the spawning time and the prices here are a little under the mean from April to June.

A close time when the quality is poor produces an economic benefit, but it has hardly an appreciable value for the propagation of the stock (Kändler, this volume). The spawning places cannot be closed to fishing in the spawning time because they are found in all deeper parts of the western Baltic, and in the central Baltic mainly in a belt of 50 to 60 m depth around the coasts, where there are also important fishing grounds for other species.

The total annual reduction between 1951 and 1956 of the stock of plaice older than 3 years was about 70 % at Bornholm, and the natural mortality is hardly greater than in the Belts, 10 to 15 % a year.

A calculation shows that the Danish catch per fishing effort would increase if the Danish size limit for commercial plaice was raised to 28 cm and possibly also to a higher size limit, and that it would decrease if a lower size limit was introduced.

Fishery

Some plaice are caught in pound nets and gill nets, especially in the western Baltic but most are caught by trawl. In the western Baltic the catch increased very much about 1912, when Danish seining was introduced, and in 1919 when the stock had recovered, but the catch decreased again. Afterwards, the Danish seine was gradually replaced by the trawl.

After about 1935 both the Danish and German yield has fluctuated about one million kilogrammes per year, in recent years with a tendency to rise because of the improvement of the stock, due to some good year-classes.

In the Baltic proper the stock was a virgin one until 1919 when seining and trawling began and the yield increased enormously until 1924. After the depletion of the stock in the course of 10 to 15 years the catch has fluctuated about a mean value, with a tendency in recent years to increase due to some good year-classes.

The stock in the western part of the Baltic proper improved during the war because of the reduced fishing intensity and the yield of the fishery therefore increased after the war, but off Blekinge (see the map, p.4) the stock did not improve. This indicated that the stock in the easternmost parts has been more affected by the depletion of the fishery and need more protection to keep it at a reasonable level (Kändler, 1954).

The fishing intensity in recent years seems to have been almost constant. In the Baltic proper most plaice are taken as a by-product of the trawl fishery for cod. The fishery takes a heavy toll of the stock of commercial fish (*op. cit.*), and in the Baltic a very large proportion of the plaice is caught before they reach maturity (Kändler and Thurow, this volume). An appropriate high size limit would therefore be beneficial for the propagation of the stock.

Flounder

Biology

The stock of flounder in the western Baltic forms part of that in the Belt Sea. The stock in the Bornholm region is self-dependent with little, if any, renewal from the western Baltic or the Sound. In the Møen region the fish are mainly of the Baltic stock but some interchanges with the western Baltic and the Sound occur.

The growth-rate in the western Baltic from 1946 to 1957, according to Kändler and Thurow (this volume), was practically the same as that found in Danish investigations in the 1940's (Blegvad, 1946). In the Baltic proper the growth-rate decreases very much towards the east (Figure 1) and in the Møen region the length of each of the age-groups II to IV was about 5 cm less than in the western Baltic. In the Bornholm region the length of the age-groups II to IV was again about 2 to 3 cm less (Jensen, this volume). To the east of Bornholm, Cieglewicz (1935 and 1947) has found a slightly slower growth-rate. This has also been stated by Mulicki (this volume) and in the eastermost part of the central Baltic, Mulicki and Zemskaja (this volume) found that the

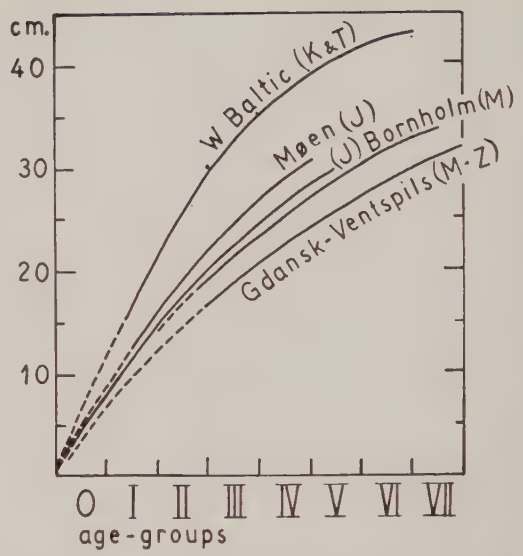

Figure 1. Growth of the flounder in various parts of the Baltic in recent years, according to Jensen (J), Kändler and Thurow (K & T), Mulicki (M), and Zemskaja (Z).

mean length of these age-groups was 0—4 cm less. The growth-rate improved very much in parallel with the reduction of the stock but it is now fairly constant (Kändler, 1954). In spite of the decrease of the growth-rate from west to east the quality (the nutrition coefficient) does not decrease towards east up to the Bornholm region (Jensen, Kändler and Thurow, and Mulicki, this volume).

Calculations of the catch per effort by different size limits for commercial fish have not been carried out. From the fact, however, that the growth-rate of the flounder in the western Baltic is not very much lower than that of the plaice, we may conclude from the results of the calculations for the latter, that the present Danish and German size limit of 25 cm is not above the length which will give the maximum yield per fishing effort.

The great decrease in growth-rate towards the east seems to justify a decrease of the size limit from west to east, since the 25 cm length is reached in the third year in the western Baltic, in the fourth year at Møen, in the fifth at Bornholm, and off Ventspils, in the sixth year. Mulicki argues for different size limits east and west of the eastern sill of the Slupsk Furrow (this volume).

The nutrition coefficient of the female flounder is very low just after spawning, and during and just after spawning they are of very much smaller commercial value than in the rest of the year. In a few summer months they recover their quality, therefore it will pay to have a close time for the fishery of female flounder in the spring months. The spawning

me is the same in the Bornholm and Gdańsk Deeps Mulicki, this volume) but a little earlier in the west-rn Baltic.

Danish experiences with somewhat different close easons have shown that a close season for female lounder greatly improves the price for the total catch f flounder in these later months.

Kändler and Thurow (this volume) have found iat the German yield (by weight) of flounder was ower in years when landing of both males and fe-iales was prohibited for a period, than it was in ther years, because the loss was not compensated for y the better yield in the remainder of the year.

It has been proposed to prohibit the landing of ill females only. This has been tried in Denmark ut it was found that many fishermen pressed the ggs out of the fish, and the empty fish were landed ith an adverse effect on the price of the flounder. It eems therefore better to prohibit the landings of all male flounders in these months.

ishery

In the western Baltic the large interest in the flounder began when the yield of the plaice fishery decreased, but from the beginning of the 1930's until 950 the Danish catch increased, whereas that of Germany was constant. In the 1950's the Danish catch ecreased, whereas that of Germany increased, but iese recent changes are due only to some changes in ie fishing effort.

In the Baltic proper the Danish catch was very irge from about 1925 to 1932 when the virgin stock as exploited but then it decreased until 1939, but fter the partially reduced fishery during the war ome improvement of the stock was found, mainly in ie Danish catches. The Swedish catch decreased un-l the war from the maximum of 1931/32 and since ien it has fluctuated about a mean value. The ger-ian catch of flounder in the Baltic proper is very mall. Polish catches per fishing effort have improved fter the restricted fishery during the last year of the ar and just after, but it soon declined again (Mu-cki, this volume). After the war the total Polish and SSR catches of flounder have increased, due main-to an increased fishing intensity. The annual catch om each of the countries has fluctuated very much recent years due to variations of the annual re-uitment to the stock because the earlier reserves of der fish have disappeared.

Dab

iology

The dab is more frequent in the western Baltic in omparison with the plaice or flounder. In the Baltic proper its quantity decreases from west to east similarly to that of the plaice. In all regions it attains maturity at a smaller size than the other two species and it is almost certain the reproduction of the stock is not influenced to any extent by the fishery. It is a competitor for food with the other species and on account of its lower commercial value there is no doubt that a large stock of dabs will be harmful to the fishery for the other two species of flatfish. Accordingly, it is thought that it will not pay, from the fishery biological point of view, to introduce any protection for the dab. In Denmark the commercial size limit is 25 cm because Danish fishermen have found that landing of smaller sizes will lower the prices for dabs so much that the economical output of the fishery will go down.

Fishery

The landing of dab in the western Baltic started at the same time as that of the flounder, when the plaice became scarce. Since then the catch has fluctuated about a mean value. Also in the Baltic proper, dabs were landed when plaice and flounder became scarce.

Turbot

The turbot is relatively abundant in the western Baltic and around Bornholm but is rare further to the east. The growth-rate is considerably lower at Bornholm than in the western Baltic and Mulicki (this volume) shows that it is smaller off Gdańsk than in the Bay of Pomerania. The spawning time is from April to August in the western Baltic, and in the central Baltic it is in June and July.

The yield of the fishery in the western Baltic is very small. In the Baltic proper the yield is generally lower than in the 1920's and 1930's, and an international size limit would be a benefit to the fishermen.

Brill

The brill is generally more abundant than the turbot in the western Baltic, but in the Baltic proper the frequency decreases more to the east than that of the turbot, and at Bornholm it is rare. Also, the growth-rate decreases to the east. The yield of the fishery is very small in the western Baltic, and in the Baltic proper it has fluctuated according to the strength of the year-classes. It is fished together with plaice and flounder, and the fishery must reduce the stock of commercial size brill to the same large extent. The growth-rate of the brill is good and an international size limit will pay, but this should be lower in the eastern waters, as in the case of the other flatfishes.

Selection of Meshes

G. Otterlind and G. Sellerberg in a paper read at the meeting in 1957 but not included in this volume, gave some preliminary results of Swedish experiments of the selection factors of cotton trawls with manila cod-ends. The cod-ends were new and the netting was stiff with loose knots. The selection factors for cod and whiting were lower than those found by other authors, and the fear was expressed that it may be possible to produce cod-ends of legal mesh size but with a very low selection effect. The results are doubtful because the cover might have impeded the escape of the fish from the cod-end, and further investigations were planned.

Polish investigations of selection of cod by cod-ends of different materials have been reported by Cieglewicz and Strzyzewski (this volume). They showed that the selectivity of the fine cotton (3.7) and hemp (3.6) was higher than for manila (3.4) and sisal (3.0) but for coarse cotton it was just as low (3.1). Owing to the pressure used for measuring the mesh sizes (2 kg) the figures for the manila and sisal should perhaps be 3.3 and 2.9, respectively, when compared with the results for the North Sea. It is seen that the values found for the Baltic are about the same as found, for instance, by the *ad hoc* Committee. According to the selectivity of the light trawls the 50 % point is found at about 30 cm length of the cod by 80 mm meshes, and it was agreed to propose a minimum mesh if this size be introduced internationally. According to the same paper the length/girth factor of the cod seems to be about the same as in the North Sea.

Conclusion

Most of the authors of the papers in this volume have suggested proposals for protecting the stocks. At the meeting, various measures were discussed and the scientists agreed that international protective measures would increase the commercial catch per unit of fishing effort and therefore a new fisheries convention for the Baltic would be in the interests of the fishermen.

It was thought that advance publication of the protective measures which the scientists consider to be beneficial would help to ensure the success of a meeting of relevant authorities (representatives of fishing administrations, research institutes, and fishermen's organizations of Baltic countries) to discuss the introduction of a new convention.

The following proposals for the protection of the stocks of fish were agreed:—

(1) For some species international protective measures should be different for the western and eastern parts of the Baltic respectively, the limit between the areas being a line between the Rügen and the southern entrance to the Sound or to southern Scania.

(2) For the plaice a size limit in the western part of at least 25 cm and in the eastern part of at least 23 cm.

(3) For the flounder a size limit in the western part of at least 23 cm and in the eastern part of at least 21 cm.

(4) For the turbot a size limit in the western part of at least 30 cm and in the eastern part of at least 23 cm.

(5) For the brill a size limit in the western part of at least 30 cm and in the eastern part of at least 23 cm.

(6) For the dab no protective measures are needed.

(7) For ripe and spent females of plaice and flounders a close time of at least two months.

(8) For the cod a size limit of 30 cm.

(9) The cod-end meshes for demersal trawls to be 80 mm (lumen of meshes).

(10) For the fishing by trawl of unprotected species, up to 10 % by weight of undersized fish should be permitted to be landed for the time being.

Recommendation

The following recommendation was passed:—

Having discussed the present state of the stocks of fish in the Baltic, the Baltic-Belt Seas Committee realizes the urgent need for international protective measures. Accordingly, it has been recommended that a meeting of Baltic member countries should be convened at a convenient place to discuss a convention for the protection of the stocks of fish in the Baltic.

Aage J. C. Jensen

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1.

Danish Investigations on the Stocks of Cod, Plaice, Flounder, and Dab in the Central Baltic and the Fishery for these Species in the Western Baltic

By

Aage J. C. Jensen

I. The Danish Fishing Methods

Fishing for cod and flatfish is done mostly by cutters of 5 to 35 gross tonnage. Those of 5 to 10 gross tonnage have motors of about 25 to 35 h.p., and those of 15 to 35 gross tonnage, motors of 60 to 70 h.p. A few have engines of 100 to 150 h.p. and power is gradually being increased. Between 20 and 60 gross tonnage (t) the length in metres is approximately $8.5 \text{ m} + 0.2 \times \text{t}$.

The cutters are mostly used for trawling but the majority of the small ones in the Bornholm region fish with long-lines during the summer when the cod move too quickly to be taken by the trawl. Some of the larger trawlers in the central Baltic also use long-lines for cod in season, as well as for flounder on the Middle Bank. Hand-lines for cod are used from boats and also from a few cutters up to about 15 B.R.T., while the Danish seine is used, chiefly for flatfish, from a few cutters in the western Baltic and in the Møen region. Net fishing is carried on near the coasts for flatfish.

Pound nets take a considerable amount of cod, flounder, and plaice in the western Baltic and along the Baltic shores of Seeland, Møen, and Falster, and cod are also taken in traps, but is is not possible to ascertain from the Danish statistics the quantities landed by the different methods.

The trawls are made almost exclusively of cotton twine, and the cod-ends are frequently made of nylon. The length of the groundrope varies between 60 to 80 feet between the dan lenos. In recent years nearly all the trawls used in the central Baltic have been fitted with rollers (bobbins) of 10 to 15 cm in diameter, and 1 litre metal floats are increasingly being used. Most of the trawls used are cod trawls which also take flatfish. Plaice trawls or flatfish trawls on the other hand, generally take only a few cod and these are used locally in the western Baltic but very seldom at Bornholm. The mesh size (knot to knot in mm) is as follows:—

	Cod trawl	Plaice trawl	Cotton twine
Wings	60–80	60	No. (12/15)–12/18
Cod-end	40–45	45–50	No. 12/45

II. The Cod

A. Biology

(a) Spawning

Observations in recent years confirm that the spawning for cod in the central Baltic is from April to August, but a few fish may spawn earlier or later than this. The spawning place at Bornholm is mainly the Bornholm Deep, but spawning takes place also to the west of the island, and it has been found that in some years in the Bornholm Deep the spawning may be hampered by the low oxygen content. Spawning begins when the cod has reached a length of about 30 cm.

(b) The growth-rate

The growth-rate is shown in Figure 1. It fluctuates from year to year but on the average it does not seem to have varied very much during the last 20 years.

(c) Migrations and interchanges of stocks

The stock of cod in the western Baltic forms a part of the Belt Sea stock, and is renewed by eggs and larvae carried in by the currents from the Belts each year. Yet the cod which migrate into the area will

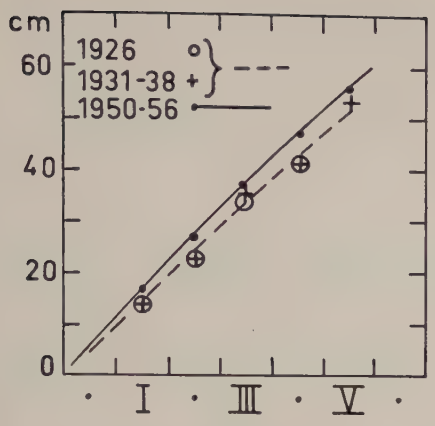

Figure 1. Length of the age-groups of cod in the Bornholm region.

nostly stay there or in the Little Belt, for recent agging experiments in the western Baltic and the outhern Little Belt have shown that nearly all cod respective of their size are recaught in the same aters in which they were tagged.

In the eight samples from Bornholm and the Baltic roper, east and north-east of Bornholm, investigated y Johs. Schmidt (1929), the mean number of fin ays in the second dorsal fin (D_2) was between 17.2 nd 17.9, but in samples from Møen, the western altic, the Belts, and the southern Kattegat it was be-ween 18.5 and 18.6. A sample from southern Scania howed a count of 18.2, intermediate between the eans for the two regions. Poulsen (1931) also found mean count of 17.4 fin rays at Bornholm and 18.4 18.6 in the western Baltic and the Belt Sea, and 8.7 in the Kattegat. It is evident that the racial char-cters of the cod at Bornholm and further to the east nd north-east are different from those of the cod in he Belt Sea and Kattegat, but that intermixing be-ween the races may take place in the western part of he Baltic proper. Poulsen also found that the mean umber of fin rays in a sample from the southern ittle Belt increased from 18.3 (22) in the II-group 18.7 (67) in the IV-group, and from 17.15 (39) in he II-group to 17.6 (47) in the III- to IV-groups in ne of the samples from the Bornholm region, and oncluded that this was due to an immigration into he Baltic of the young cod. The small number of cod nvestigated (shown in brackets) makes the conclu-ion doubtful, but so far it seems to have been con-rmed by a Danish tagging experiment in the Sound here one or two cod have been recaptured at the ntrance to the Baltic proper. On the other hand, one of the many recaptures from the recent Danish aggings of cod in the Belt Sea have been taken in he Baltic proper, and the similar experiments in earlier years (Strubberg, 1922) showed only a slight tendency for the younger cod to migrate towards the Baltic proper.

A certain number of eggs and larvae must be brought into the Baltic proper by the currents, as considerable numbers are sometimes found at the entrance to the Fehmarnbelt as shown by Kändler (1952), and an exchange of adult cod between the Baltic proper and the western Baltic, Belts, and Kattegat has been shown by recent Danish tagging experiments. The stock in the Møen region must be influenced to an appreciable degree by these migrations. The stock in the central and eastern parts of the Baltic proper must, on the other hand, be mainly independent. Danish tagging experiments in recent years have shown that cod from the central Baltic may migrate to the Belt Sea, but the recoveries from that region have been very few in proportion to those recovered in the Baltic proper. Also, the occurrence of a high percentage of bullhead cod of the 1950 year-class, which were observed at Bornholm in 1951 and the following years (Aa. J. C. Jensen, 1952, 1953), but not found in the western Baltic, the Belts, or the Kattegat, confirms that almost no cod migrate between the central Baltic and the above named areas.

Besides the regular migrations between the spawning grounds in the deeper parts of the sea and the feeding grounds at lesser depths, irregular migrations due to hydrographical factors can influence the fishery. In some years, for instance, fishing at Bornholm is mostly done to the west of the island or on the Middle Bank, when the oxygen content in the Bornholm Deep is low, and differences in the quality of the cod may sometimes occur rapidly, indicating irregular migrations. The recent Danish tagging experiments have shown that irregular long-distance migrations in the central Baltic are frequent, and Alander (1948) has also found that such migrations in the Baltic may occur. They have been further confirmed by the tagging experiments of Mulicki and Otterlind.

(d) Fluctuations in the size of the stock

These have been mentioned in a previous paper (Aa. J. C. Jensen, 1954). The stock density may have been greater during and just after the war than in recent years. It is said that in the 1940's the long-lines often had a cod on each hook, but today the number caught is considerably less. Trawls have been improved and the horse-power increased but on board the trawlers there are also signs of a decline.

In the Bornholm region the size of the stock fluctuates very much from one year to another, due to the irregular migrations, but the causes of the long-period

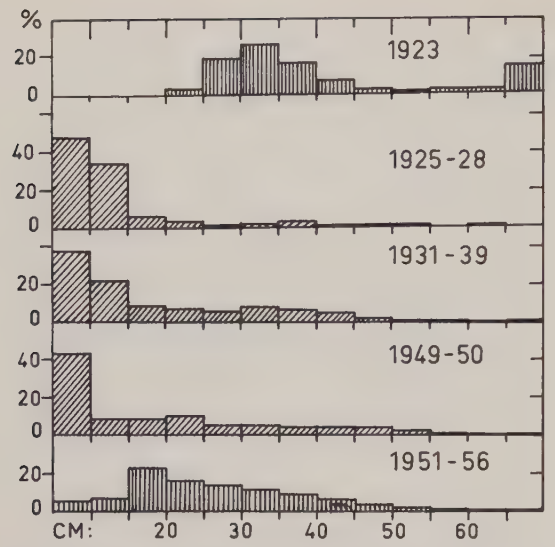

Figure 2. Percentage length composition (5 cm groups) of catches taken in the Bornholm region from July to September by Danish research vessels. In 1923 and in 1951 to 1956 by trawl and in the other years by eel-tog.

changes are shown to be mainly hydrographical, although fishing must also have some influence (see Section B 3).

(e) Length compositions

Length compositions of the catches from the research vessels (see Figures 2 and 3) show great fluctuations over the years. Sometimes one can follow a good year-class from year to year, from the 0- or I-group to the III-group, but very often the changing length composition shows that the distribution of the stock has shifted.

B. Fishery

1. Statistics

(a) Statistics of the Danish catch in the Baltic are shown in Figure 4. The Danish fishery for cod in the western and central Baltic increased very much with the simultaneous increase of the stock in the 1930's. On the whole, the catch has been increasing since 1941 on account of increased fishing. The decline in 1945 in the central Baltic was due mainly to market conditions.

(b) The seasonal variation of the catch (see Figure 5 A). In the western Baltic the fishing mainly takes place in winter when the cod are concentrated in the deeper parts. In the central Baltic, the yearly changes are less marked but most fish are caught during February and March.

(c) The collection of information on the yield per fishing effort for Bornholm has just started.

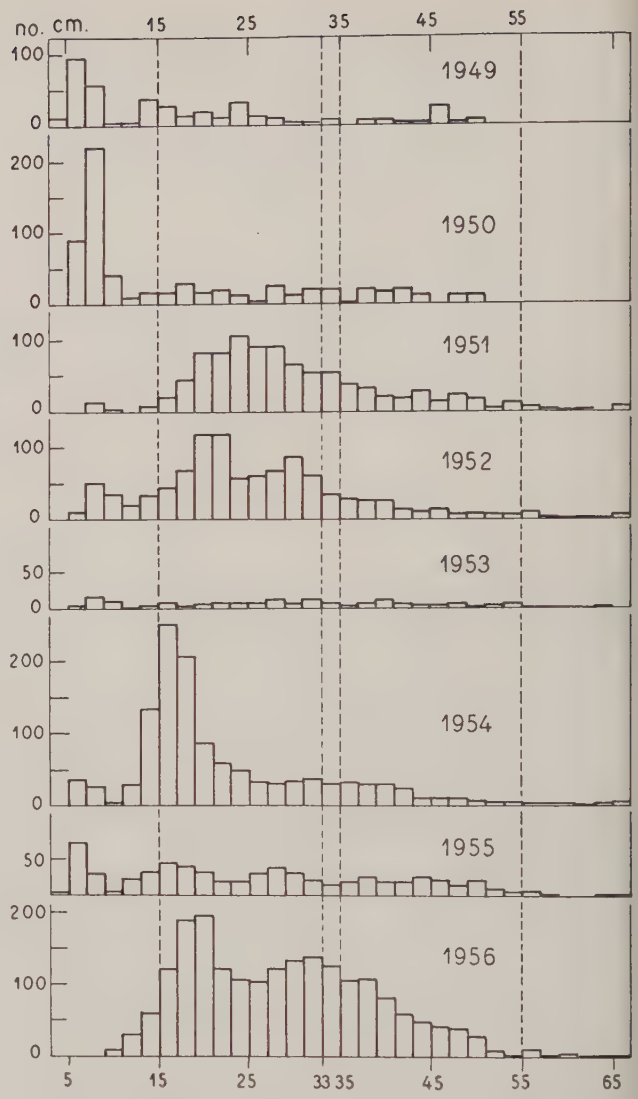

Figure 3. Length composition of cod (2 cm groups) per 5 hours' trawling with the R/V "Biologen" in the Bornholm region. In 1949/50 the eel-tog was used, after 1951 the standard trawl.

2. Quality of the cod

(a) Investigations into the length composition of the commercial catch of cod have been started at Bornholm.

(b) The nutrition coefficient has been investigated from Denmark in the late summer when most of the adult cod at Bornholm are spent and thin. In 1954 their k was about 0.8 in each catch investigated west of Bornholm and 0.7 east of Bornholm. One fish of 71 cm in length had a k of 0.49. In 1955 only a few were investigated. South of Bornholm in 35 m depth the k was 0.95 for cod of 41—49 cm in length and 0.86 for two cod of 103—144 cm. In 1956 the k was again about 0.8.

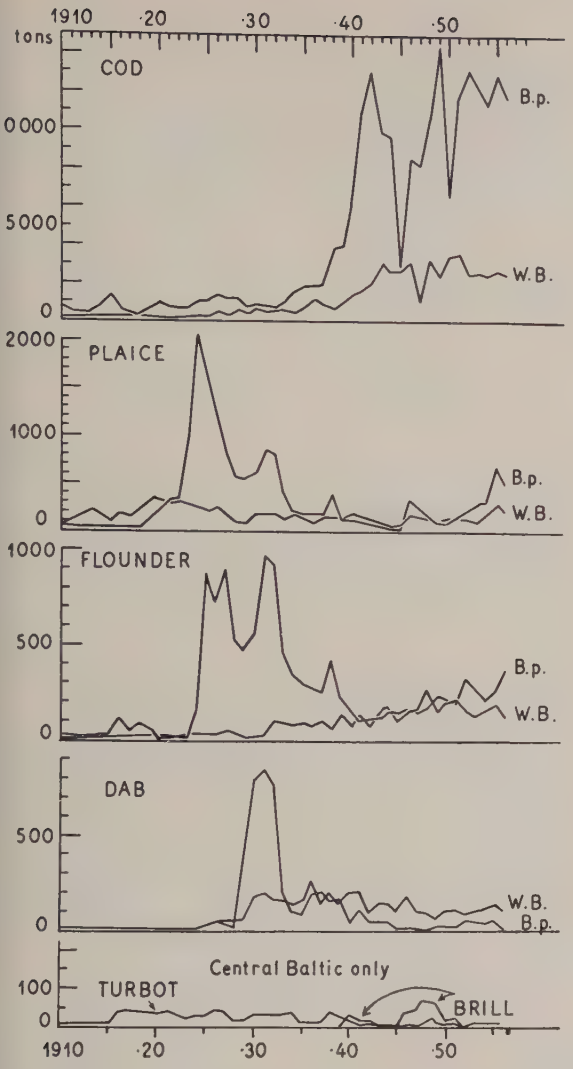

Figure 4. The Danish catch of cod, plaice, flounder, and dab in the Baltic. B.p. = Baltic proper (between Falster-Møen-Seeland and about 18°E, W.B = Western Baltic.

The quality of a few young and immature cod examined in 1954 was about the same as the adults. In 1955 the k of 7 cm to 26 cm cod west of Bornholm was 0.68 but a few of between 29 and 34 cm caught south of Bornholm had a k of 1.1. In the Møen region a few cod of 15 to 23 cm and 48 to 56 cm in length had a k of 0.8 in August 1954.

The prices shown in Figure 5 B are highest in autumn and winter, mostly because the public prefer the cod in these seasons.

3. Natural mortality and fishing mortality

The average percentage age composition in the Bornholm region as observed in the catches from the "Biologen" during 1951 to 1956 was a follows:—

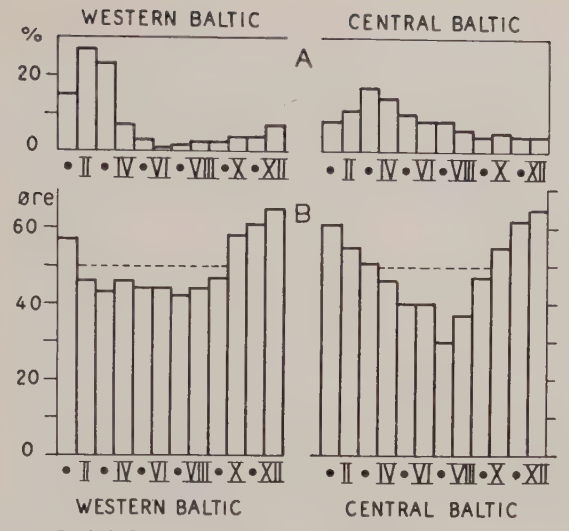

Figure 5. (A) Percentage monthly Danish catches of cod in the Baltic, 1952—1956. (B) Monthly Danish prices per kg of cod in the Baltic, 1952—1956.

0	I	II	III	IV	V	VI	VII +
2	37	33	20	6	1.1	0.3	0.8

The decrease in number from the I-group to the II-group is normally larger than in these figures, where the extraordinarily large number of II-group cod in 1951 has affected the average.

The real yearly decrease from one age-group to the next in the following year was:—

	Between I- and III-group %	Between III- and VII-group %
1925–28	51	45
1931–35		35
1935–39	47	76
1951–57	47	79

The figure for the reduction between the I- and III-group from 1951 to 1957 differs very much from that in the paper (Jensen, 1954) for the years 1950/1953, the low figure then being due to the inclusion in the calculation of the year 1950. It has been excluded here because the fishing until 1950 was carried out with the eel-tog whereas the larger gear, the standard trawl, has been used in the following years.

It can be seen that, after 1935, the reduction of cod older than the III-group, i.e., the age when it has reached a size suitable for human consumption, has been much larger than before.

It must be added that the yearly reduction has varied very much from year to year, and the great variations in the amount caught per fishing unit from the research vessels are due to the irregular migrations.

Possibly an effect of the migrations may be included in the reduction found, but this question can only be answered with the aid of tagging experiments and also by investigations into the yearly reduction in all other regions of the Baltic.

The total reduction of the III-VII groups is about the same as in the Belt Sea.

The yearly reduction between the I- and III-group is the same in the periods considered. In these age-groups the fishery had a small reducing effect on the stock, and we may assume that most of the reduction was due to natural mortality. If it was influenced very much by migrations, one might expect that it would have varied more, but naturally it may be influenced by a regular migration from the rocky grounds to the trawling grounds, if the young fish prefer the rocky grounds, but of this, nothing is as yet known. The natural mortality of the cod of the III-group and older, i.e., fish of more than about 30 cm in length, is no doubt somewhat less than that of the younger fish of 10 to 30 cm in length, but it is most likely that it is larger than in the North Sea and the Belt Sea, because it is known that the nutrition conditions may be very unfavourable for the cod in the Baltic.

4. Change of catch per fishing effort if the minimum size is changed

Calculations of the catch with different size limits for the cod in the central Baltic are uncertain, because the exact rate of natural mortality is not known, but it can be calculated using various values for this factor.

The total yearly reduction of the stock is about 80 % for cod of more than 3 years of age. The "natural mortality" may be as high as 40 % annually, and therefore calculations have been made for an annual "natural mortality" of 10, 30, and 40 %, which at the higher mortalities may include an emigration from the areas of the central Baltic investigated by Denmark.

If the size limit for commercial cod was raised 10 cm (or the growth of a year), the increase in the weight of the commercial catch per fishing unit would be:—

For	10 %	natural	mortality	70 %
„	30 %	„	„	50 %
„	40 %	„	„	30 %

The increase in the catch by an increase by only 1 cm would roughly be one-tenth of these amounts.

It is certain that an increase in the size limit for cod will be profitable in some few years, and corresponding calculations show that a loss in the fishery will result from a lowering of the size limit.

5. Proposed protection measures for the cod

As a result of the calculations in Section 4, it is recommended that an international size limit be fixed for cod in the central Baltic at least as high as the Danish size limit of 33 cm. For Denmark, it should not be necessary to fix a minimum mesh size for the trawl because the fishermen adapt the mesh size according to the size limit for the fish. The trawls are made of cotton, and the few undersized cod caught by them can generally be released alive.

III. Plaice

A. Biology

(a) Spawning

No recent Danish observations on the spawning or spawning places of the plaice are available, but in the central Baltic it seems to take place mostly near the upper parts of the lower water layer and mainly in March and April in the Bornholm region, although some of the fish may spawn even later than this.

(b) Growth-rate now and in previous years

This is shown in Figure 6. Growth in the Bornholm region was very slow in the dense stock found up to the 1920's when the trawl (or seine) fishery started. At the end of that period the old, slow-growing fish disappeared, and the growth since then has not changed very much, although a smaller increase has been noted. The secular change in the hydrographic conditions in the Baltic, especially the higher temperatures and stronger inflows of water through the Sound and the Belts may be assumed to have been a contributary cause of the recent increase.

(c) Migrations

At the end of April, just after spawning, the plaice from the area east of Bornholm migrate towards the boundary between the hard and the soft bottom in about 60 m depth, and then about June, most of them seem to retire to shallower depths. Very long migrations seem to be rare but tagging experiments are needed to investigate this.

(d) Fluctuations in the size of the stock

The stock of plaice in the central Baltic was sparse during the war and in the first years after the war,

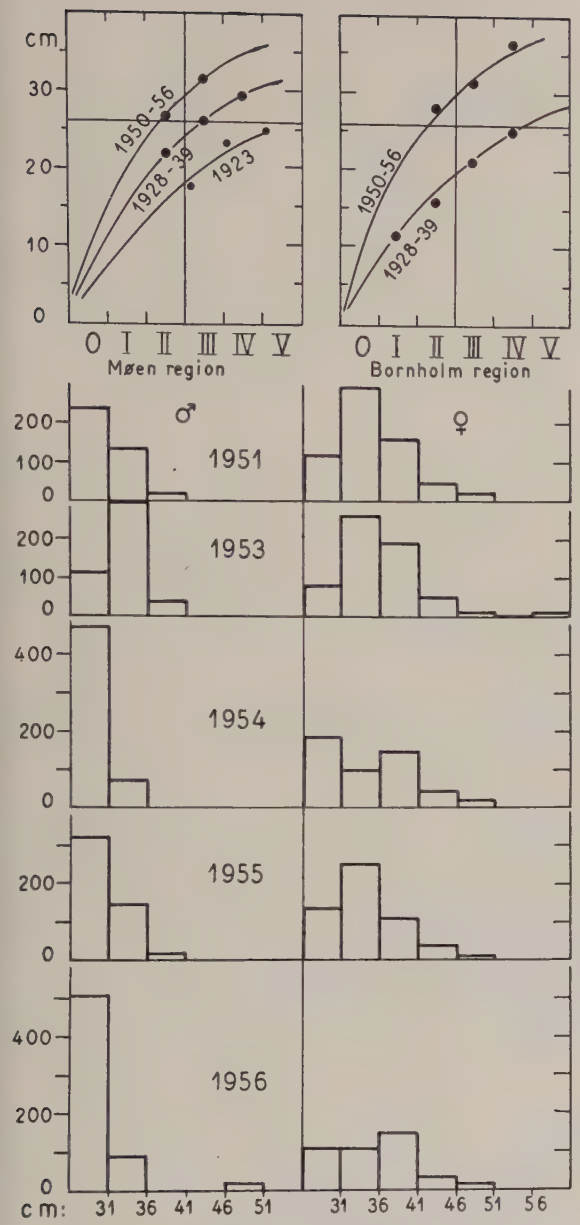

Figure 6. Length of the age-groups of plaice in the central Baltic.

Figure 7. Length of plaice (5 cm groups) at Bornholm in September/December.

especially in the Bornholm region. In recent years both the stock and the yield of the fishery have increased. There is hardly any doubt that the decline during the 1930's was mainly due to fishing, but the increase in the stock of cod during that time may have been a contributory factor, because young plaice, until they reach 15 to 20 cm in length, are eaten by the cod, and furthermore, a minor decrease in the density of cod in recent years may have contributed to the contemporary increase in the stock of plaice. Fluctuations in the strength of the age-groups due to meteorological and hydrographical influence must also play a considerable part in determining the size of the stock.

B. Fisheries

1. Statistics

(a) The total Danish catch of plaice (see Figure 4) increased in the western Baltic when the more intensive fishery with the otter seine and the Danish seine started between 1910 and 1912. The catch reached a maximum in 1913, and following the restricted fishery during the 1914/1918 war the thinned stock recovered and the yield of the fishery increased again in 1919/1922. After that it fell again, and from 1927 to 1941 or 1942 it fluctuated about an average of approximately one million kg a year. During the second World War, the restricted fishery in the neighbouring Belts allowed the stock to recover a little but not nearly as much as in the Belts, where the yield increased to four times the pre-war level. In the central Baltic the intensive fishery started about 1922, and the total catch rose to 2 million kg in 1924, with the contemporary improvement of the quality of the depleted stock. This stock, however, could not support the intensive fishery and in consequence, the catch fell, although some good year-classes caused occasional fluctuations. It has been mentioned above that the density of the stock of cod may have been a contributory cause of the low catch from about 1935 to 1950, and that the minor decrease in the density of the stock of cod may have contributed to the increase in the catch of plaice in recent years.

(b) The seasonal variations of the Danish catch are shown in Figure 8 A. In the western Baltic the catch shows a distinct maximum in December and January when the plaice are concentrated on the spawning grounds, but it decreases in February, partly on account of the lesser interest taken by the trade due to the low quality of the plaice at the end of the spawning season and just afterwards. In the central Baltic the seasonal variations are less, and the highest catch occurs in November and December.

2. Quality of the plaice

(a) Length compositions of Danish commercial catches at Bornholm are shown in Figure 7. It is seen that most of the plaice have been relatively large, more than 30 cm.

(b) Nutrition coefficient. In the Møen region the k was 1.23 for 26 plaice of 21 to 36 cm in length fished from the "Biologen" in August 1954, all fish showing nearly the same quality. In the Bornholm

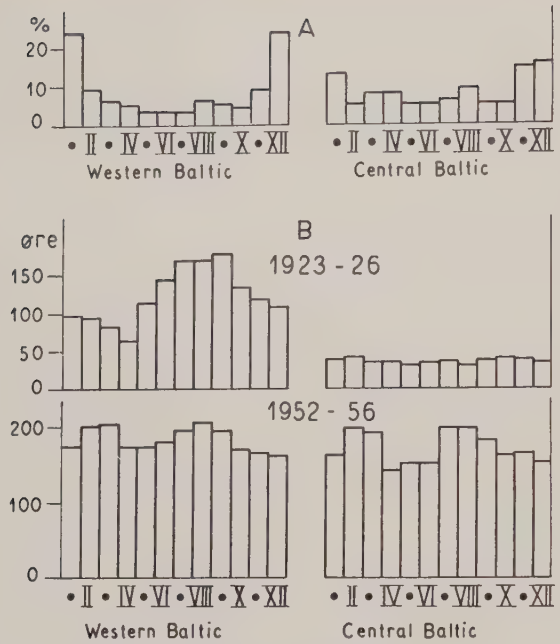

Figure 8. (A) Percentage monthly Danish catches of plaice in the Baltic in 1952—1956. (B) Monthly Danish prices pr. kg af plaice in the Baltic.

region a few fish of 24 to 27 cm in length in August 1954 had a k of 1.02, whereas some of 36 to 40 cm had a k of 1.24. The quality may vary from year to year but it is mostly good in the late summer.

In Figure 8 B the price of plaice in the different months is shown. In the western Baltic the prices in 1923—1926 were low from January to April owing to the poor condition of the spawning fish. From 1952 to 1956 the price was almost the same at all seasons, but it was best in February and March due to the prohibition of the landing of female plaice during the period 15. January to 15. March if their roe occupied more than half the total length of the fish. In the central Baltic the prices from 1923 to 1926 were very low at Bornholm (only the prices at Bornholm are shown from A. C. Johansen (1928) for these years) owing to the bad quality of a large part of the catch. From 1952 to 1956 prices were almost as high in the central Baltic as in the western Baltic or the Belts, but they were lowest from April to June, during the spawning season and just after. The prohibition of the landing of female plaice, as mentioned above, produced relatively good prices in March.

3. Natural mortality and fishing mortality

The total annual reduction of the stock of plaice of more than three years of age between 1951 and 1956 was about 70 %, but this figure is unreliable because of the small numbers examined. The quality of the plaice is mostly just as good as in the Belts, and there is no reason to believe that the natural mortality is larger than there, about 10—15 % annually.

4. Proposed protection measures

Calculations have shown that if the Danish size limit of 260 mm for plaice is raised to 280 mm or more, the catch will increase, and that it will decrease if a lower size limit is introduced. Therefore, the introduction of an international size limit for plaice, not less than that adopted by Denmark is recommended. In Denmark the introduction of a prohibition against landing female plaice from 15. January to 15. March has proved very profitable, and an international prohibition is recommended, but it would pay to introduce it during the months of December to June.

IV. The Flounder

A. Biology

(a) Spawning

Danish observations in recent years are few. On the coasts of Bornholm, 0-group flounder are found in most years in much greater density than on other Danish coasts (exclusive of some inshore waters).

(b) Growth-rates

Growth-rates now and in previous years are shown in Figure 9. The length of the age-groups has increased parallel to the depletion of the stock, now nearly the same as in the Belts.

(c) Migrations

In the central Baltic no recent, and very few older Danish observations are available.

(d) For fluctuations of the stock, see below.

B. Fisheries

1. Statistics

(a) The total Danish catch of flounder is shown in Figure 4, p. 17. The more intensive fishery for flounder in the western Baltic started later than the fishery for plaice. The catch increased until about 1950 but thereafter it declined because the dense virgin stock was thinned out. In the central Baltic the intensive fishery started a few years after that for plaice, and the catches became large from 1925 to 1932, but then the original dense stock was also depleted on these grounds and the catch fell rapidly to less than half. The small increase in recent years

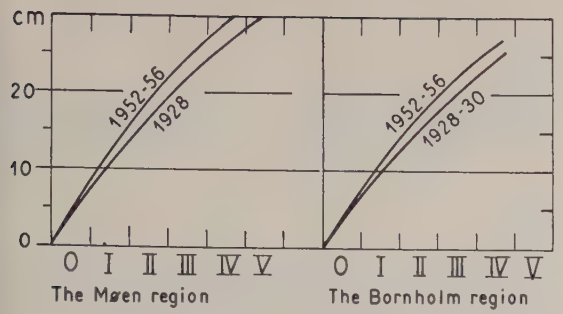

Figure 9. Length of the age-groups of flounder in the central Baltic.

has been similar to that for the plaice, and it must be assumed that it is caused by the same factors, i.e., a minor decrease of the stock of predatory cod and possibly also a change in the hydrography of the area.

(b) Seasonal variations in the yield are shown in Figure 10 A. In the western Baltic the catches have a pronounced maximum in the winter months, especially immediately before the spawning season. In the central Baltic the catches are relatively low from March to June and highest in the late autumn. The small catches of flounder in the spring and early summer are no doubt influenced by the low quality of the fish in the spawning season and just after.

2. Quality of the flounder

(a) On the length composition of the commercial catch no Danish observations are available for recent years.

(b) Nutrition coefficients of the flounder at Bornholm in five catches taken between September and January in the years 1931 to 1935 was: for males of 18 to 34 cm in length, 1.18, and for females of 20 to 41 cm in length, 1.28 to 1.37. In August 1954 the k of a few fish in the Møen region was 1.1.

The Danish average price in each month is shown in Figure 10 B. In the western Baltic it was low from January to February, but good for the rest of the year. The Danish prohibition of landing female flounder from 1. March to 15. May has improved the prices in these months. In the central Baltic the prices from 1928 to 1930 (taken from H. Blegvad (1932)

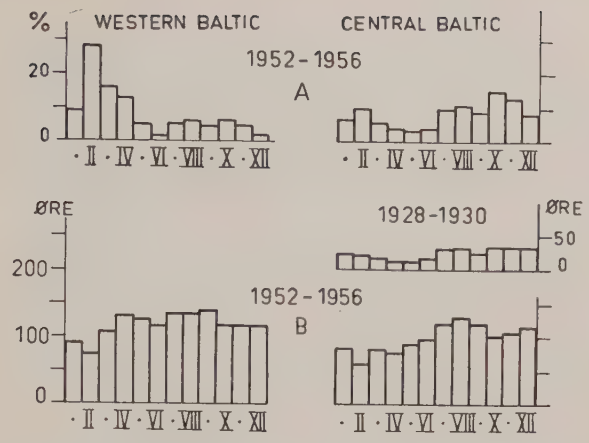

Figure 10. (A) Percentage monthly Danish catches of flounder in the Baltic. (B) Monthly Danish prices per kg of flounder in the Baltic.

and only for eastern Bornholm), and from 1952 to 1956, show about the same seasonal variation. The bad quality of the flounder in this region in the first half of the year is due mostly to spawning. The flounder in the central Baltic is normally of good quality in the last half of the year.

(c) Natural mortality and fishing mortality are not known from Danish observations in this area. It may be supposed that they are about the same as for the plaice.

3. Proposed protection measures

The Danish size limit for the flounder is 255 mm and considering this rather good growth of the fish it may be assumed that it would pay to increase it. An international size limit of at least this length is therefore recommended. The prohibition of the landing of female flounders has proved a useful measure in the western Baltic as well as in the Belts, and for the western Baltic it is proposed that it should be introduced internationally. For the central Baltic, no beneficial effect on the prices can be seen, but the more flounders that are spared during this period of low prices, the more will be caught during the rest of the year, and therefore a close time must also be recommended for the central Baltic.

V. The Dab

In the central Baltic few dab have been caught from the "Biologen", and in recent years no investigations have been made of the commercial catches. The length of the age-groups in the Møen region is shown in Figure 11. It seems to have improved a little since 1938.

The Danish catch of dab (compare Figure 4, p. 17) in the western Baltic shows a rise in 1930 when the Danish fishermen began to take more interest in this species; and it reached maxima in 1936 and 1940/41. Thereafter there was a steady but slow decrease, and the catch was stabilized at about 100 tons annually

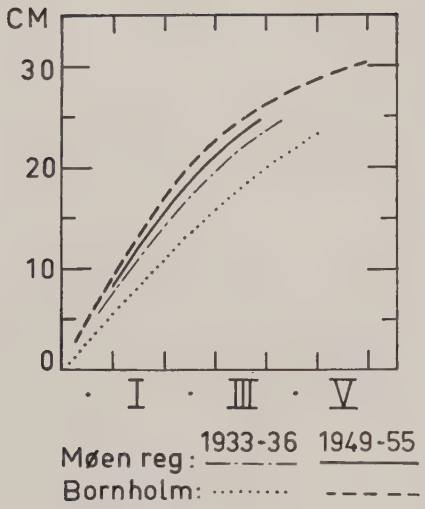

Figure 11. Length af the age-groups of dab in the Møen region and at Bornholm. (The figures for 1933—36 from Poulsen, 1938.)

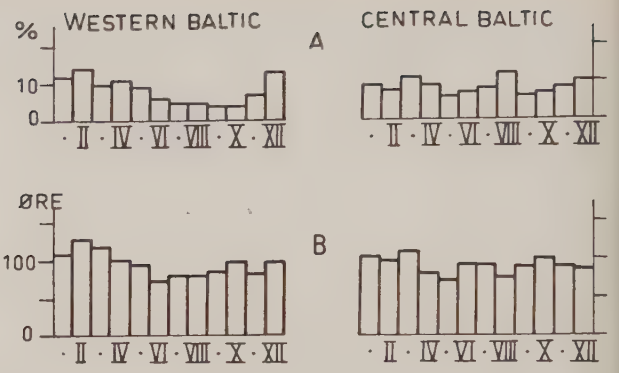

Figure 12. (A) Percentage monthly Danish catches of dab in the Baltic. (B) Monthly Danish prices per kg of dab in the Baltic, 1952—1956.

after 1948. In the central Baltic the fishery started in 1929, and the catch increased rapidly reaching a peak in 1931. The stock was rapidly depleted and the catch consequently fell abruptly, and since the beginning of the 1940's it has been very low. The landing of dabs increased when the catches of plaice decreased. The length of the age-groups increased parallel to the depletion of the stock. In the Møen region the length in 1949 to 1955 was nearly the same as in 1933 to 1936, but at Bornholm it had increased very much in the course of these twenty years. There is no doubt that there is a direct relationship between the quality (growth-rate) of the dab and of the plaice also, and the density of the stock of the other species, since they are, to a considerable extent, all competitors for food in these waters.

The seasonal variations in the catches are shown in Figure 12 A. The nutrition coefficient to the east of Bornholm of dab fished in February 1938 was 1.1 for 7 males from 28 to 30 cm and 113 females from 27 to 35 cm in length. In September 1954 a few dab from 10 to 16 cm at Bornholm had a k of 1.0 and from 21 to 25 cm a k of 1.2. The quality was good. The prices shown in Figure 12 B both for the western and the central Baltic, are highest during the winter and lowest during the summer.

Proposals for protective measures

The Danish size limit for dab is 250 mm. This was introduced in accordance with the desire of the fishermen to secure a good size and price for the fish. From the fishery-biological point of view it is doubtful whether it pays to protect the dab, because it is less valuable than the plaice, and a large stock of dab seems to be detrimental to the stock of plaice because of the competition for food. The extent of the damage to the plaice is unknown, and it is therefore not known how much would be gained if the dab is not protected. Investigations on this point are needed.

VI. The Turbot and the Brill

Very few fish of these species have been caught by Danish research vessels, and very few investigations of commercial catches have been carried out. The catch in the central Baltic is shown in Figure 4, p. 17. The catch of turbot increased about 1915 and amounted to between 20 and 40 tons annually until 1940. Except for a single year, it has only been about 10 tons a year since then. The catch of brill has been relatively high from 20 to 70 tons annually from 1946 to 1951, but in other years it was very small. In the western Baltic, the Danish catch of turbot fluctuated about 5 tons a year and the catch of brill is negligible. The Danish size limit is 325 mm for turbot, but at Christiansø (NE of Bornholm) it is permitted to land turbot over 210 mm in length which are caught at the islands, but only for consumption on the islands. For brill the size limit is 300 mm. The size limit of 325 and 300 mm respectively, seem to be profitable, but no doubt a higher size limit than 210 mm at Christiansø would pay.

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2.

On the Stock of Flatfish and Cod and the Yields of the German Fishery in the Baltic

By

R. Kändler and Fr. Thurow

The following observations of the actual condition of the stock of demersal fish in the western Baltic result from catches with the standard trawl, made (a) in May and October 1956 from a fishing boat, and (b) from April to June 1957 with the research vessel of the Institut für Meereskunde, Kiel. In addition, a few catches from the commercial fishery have been analysed, but this material for plaice and flounder is scarce, owing to the high cost.

Fischereiamt des Landes Schleswig-Holstein has provided the statistics, and data on the occurrence of fish eggs were obtained from vertical hauls carried out from the lightvessel in the Fehmarnbelt. Results of earlier investigations have been published in reports to the ICES.

The report "Über die Entwicklung der Fischbestände und die Fischereierträge Deutschlands in der Ostsee" forms the basis of the statements set out in the present paper. This report was presented to the Baltic-Belt Seas Committee in 1954. The necessary arrangements were almost entirely based on the outlines given by Prof. Cieglewicz.

A. Plaice (*Pleuronectes platessa* L.)

In the report "20 Jahre Schollenschonzeit" the most important results of the German investigations of the stock of plaice in the Baltic and a critical attitude towards the effect of the close period was discussed. The actual conditions of the stock of plaice, according to the new investigations, are discussed in the following.

I. Western Baltic

1. Spawning

Experimental hauls carried out in March to May 1957 give information about the time and place of spawning, and the age of the spawning fish. The investigations started in February, when spawning was already in progress, and they continued to the beginning of May.

Vertical hauls with the Hensen net (three times per month) give the better information of the spawning time. The average number of eggs found per m^2 in the different months is given in Table 1. In the western Baltic spawning commences normally in January and continues to April or May. In severe winters the onset of spawning occurs considerably later. In previous years plaice eggs were few but in the spawning period of 1957, more eggs were found.

Table 1. Average numbers of eggs found per m^2 in the Fehmarnbelt

Year	December	January	February	March	April	May	June
Mean.. 1935–43	0·6*)	0·5	1·8	1·0	1·0	–	–
1953...	–	0·5*)	–	0·5	0·5	–	–
1954...	–	–	–	–	1·0	1·0	–
1955...	–	0·5	–	1·5	0·5	–	–
1956...	–	–	–	–	0·5	0·5	0·5
1957...	–	1·0	1·5	1·0	0·5	–	–

*) Second half of month.

The yield per hour's fishing on the different fishing grounds indicates the spawning places favoured by the fish. As plaice shoals keep together during the spawning period they may be caught in relatively large quantities, as shown in Table 2.

The stock of plaice in the western Baltic is not very dense. The relatively best results were obtained in areas of comparatively great depth and influenced by waters of high salinity.

In spring 1957, hauls with the standard trawl on the spawning grounds yielded only mature plaice of age-groups II-IV (length of males 17 cm and higher, females 24 cm and higher). On the other hand, only

Table 2. Number of plaice caught per hour in March to May, 1957

Locality	Depth, m	Number of hauls	Number of plaice per hour	
Fehmarnbelt	28	1	8·0	–
Vejsnæs Rinne	29	7	3·7	(0–6·0)
S of Langeland	22	2	5·0	(4·0–6·0)
Hohwacht Bay	19	8	3·4	(2·5–4·0)
Eckernförde Bay	20	4	1·0	(0–2·0)
Lübeck Bay	22	1	0	–

Immature plaice were caught with a beach seine near Laboe (Kieler Förde). Most of the latter belonged to age-group II and were up to 30 cm (male) and 31 cm (female) long. The immature plaice evidently travel early to the shallow areas if the water becomes heated, while the mature fish stay for a longer period in deeper water. Similar observations were made in spring of 1946 when some hauls from the Fehmarnbelt contained only a few immature fish.

Table 3. Age distribution of the stock of mature plaice in Fehmarnbelt 1946, and Kiel Bay 1957

Year	Locality	II ♂	II ♀	III ♂	III ♀	IV ♂	IV ♀	V ♂	V ♀
1946	Fehmarnbelt	59	5	196	246	13	23	2	32
	♂ + ♀	64		442		36		34	
	%	11·1		76·7		6·3		5·9	
1957	Kiel Bay	74	35	39	46	24	24	–	1
	♂ + ♀	109		85		48		1	
	%	44·9		35·0		19·7		0·4	

In 1957, the proportion of the II-group among the spawning fish was remarkably high (males 54 %, females 33 %), contrary to 1946 (11 %). On the other hand, the IV-group with 20 % was threefold that in 1946, in which year the III-group amounted to 77 %, against 35 % for 1957. These fluctuations will be discussed below. The proportion of plaice older than 4 years was very small in 1957.

The plaice, especially the males, may become mature at the end of the second year. More accurate information on the age, length, and maturity of female plaice is given in the table below for the III-group in 1946:—

Length, cm	25	26	27	28	29	30	31	32	
Juvenile	1	1	1	–	1	5	5	7	
Mature	1	3	3	3	10	6	9	11	
Mature %	67		86		73		63		
Length, cm	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**Total**
Juvenile	3	2	2	–	–	–	–	–	28
Mature	4	13	7	7	8	1	1	1	88
Mature %	77		88		100		100		76

In that year 75 % of the female plaice attained maturity at the end of the third year of life. Among the IV-group only a few immature fish occurred (up to 37 cm), while, extraordinarily, some II-group females were mature (24—26 cm length). At present, this proportion has risen considerably, up to 33 % of the fish caught.

2. Growth

The results of the age determinations of 600 plaice from experimental and commercial catches made in spring 1957, are indicated in Table 4.

Table 4. Length and age composition of plaice in commercial catches in the western Baltic in the spring of 1957

Length, cm	II ♂	II ♀	III ♂	III ♀	IV ♂	IV ♀	Total ♂	Total ♀
20	3	–	–	–	–	–	3	–
21	9	3	–	–	–	–	9	3
22	42	36	–	–	–	–	42	36
23	51	48	1	–	–	–	52	48
24	60	44	1	3	–	–	61	47
25	38	34	5	5	–	–	43	39
26	13	12	2	3	1	–	16	15
27	9	9	6	5	1	–	16	14
28	8	6	8	4	1	–	17	10
29	10	6	9	5	1	–	20	11
30	2	5	3	2	2	–	7	7
31	–	3	3	5	3	–	6	8
32	–	1	4	5	4	2	8	8
33	–	1	2	4	2	1	4	6
34	–	–	–	4	5	2	5	6
35	–	–	–	2	1	1	1	3
36	–	–	–	3	2	2	2	5
37	–	–	–	2	1	3	1	5
38	–	–	–	1	–	3	–	4
39	–	–	–	2	–	4	–	6
40	–	–	–	–	–	3	–	3
41	–	–	–	–	–	3	–	3
Total	245	208	44	55	24	24	313	287
Mean length in cm	24·5	24·8	29·0	31·0	32·7	37·9	25·8	27·1
Total ♂ + ♀	453		99		48		600	
%	75·5		16·5		8·0		–	

The average values agree approximately with earlier results (1952/53 and 1946). Considerable changes in the rate of growth did not occur.

Table 5. Average lengths of age-groups II–IV in the period 1946–1957 (in cm)

Year	Age-groups II ♂	II ♀	III ♂	III ♀	IV ♂	IV ♀	V ♀	VI ♀	VII ♀
1957	24·5	24·8	29·0	31·0	32·7	37·9	–	–	–
1952–53	24·9	27·1	28·4	32·6	33·4	37·3	39·7	41·3	45·0
1946	24·9	25·0	28·5	32·8	32·9	37·8	40·6	43·3	42·8

In 1957, the average length of the II-group was a little lower than in the years past, as the immature fish caught in the shallow water were smaller than

Table 7. Monthly landings of plaice from the western Baltic in tons

Year	Months												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
1949	15	15	12	2	1	2	1	3	4	3	5	9	72
1950	20	0	0	3	3	3	2	5	4	5	7	16	69
1951	24	8	3	3	2	3	4	6	5	5	3	16	84
1952	36	13	6	6	3	4	3	3	2	4	7	19	106
1953	22	0	0	4	2	1	2	3	5	11	7	21	78
1954	20	0	0	10	12	7	6	8	15	15	18	30	141
1955	29	14	16	10	12	9	8	14	8	6	12	23	163
1956	36	3	12	13	8	5	2	2	5	9	13	19	127
1957	18	9	6	16	11	7	7	–	–	–	–	–	(74)
Mean of 1950, 1953/54 in %	22	0	0	6	6	4	3	6	8	11	11	23	
Mean of 1949, 51, 52, 55, 56 in %	26	10	9	6	5	4	3	5	4	5	7	16	

the mature individuals from deeper waters. The latter averaged 25·6 cm (males) and 28·3 cm (females) in length.

3. Composition of the stock

Since 1949 the statistics show an increase in the yields landed in the ports of Schleswig-Holstein from the western Baltic (Table 6).

Table 6. The German catch of plaice from the western Baltic landed in Schleswig-Holstein

Year	Tons	Average for 5 years	
		1925/29	161
		1930/34	116
		1935/39	62
		1940/44	35
1945	21		
1946	38		
1947	18	1945/49	40
1948	50		
1949	72		
1950	69		
1951	84		
1952	106	1950/54	96
1953	78		
1954	141		
1955	163		
1956	127	1955/56	145

The data for 1940 to 1948 are incomplete, on account of the war. After a long time, more than 100 tons were again landed in 1952. The year 1955 brought a maximum yield of 163 tons, corresponding to the average for 1925 to 1929. The close period in February and March, included in the International Convention for the Baltic Fishery, 1929, was observed in 1950, 1953, and 1954. Since 1955, only the landing of mature females in these months has been prohibited. In winter, mature plaice assemble on the spawning grounds in deep water, where they can easily be caught by the trawl.

In December and January, just before the main spawning time, 42 % (loosely close time) or 45 % (strictly close time) of the annual yield has been landed. In the years with a close period only for females, the average landings of the four months December to March are 61 %, contrary to 39 % for the remaining months. In a strictly close period 55 % of the annual catch is landed in April to November. It is remarkable that the increase of the yield took place in years with loosely close time. Evidently there is no connexion between increase of the yields and the loosely close time.

Table 8. Length composition of plaice caught in a standard trawl in the western Baltic

Length groups, cm	May 1956		October 1956		April/May 1957	
	Number	%	Number	%	Number	%
10–15	–	–	1	1	–	–
16–20	–	–	17	18	3	1·2
21–25	6	16	46	48	53	21·9
26–30	10	27	18	19	103	42·6
31–35	15	41	11	12	54	22·3
36–40	6	16	2	2	26	10·8
41–45	–	–	–	–	3	1·2
Mean length, cm	31·2		24·8		29·8	

In autumn, contrary to spring, the average length is considerably smaller on account of the presence of age-group I. On the other hand, the smaller average length in 1957 is due to another composition of the year-classes. There is at least a very good agreement between the average length of the standard trawl catches from May 1956 and the commercial catches from March 1956 (31·3 cm).

In consequence of the different growth-rates and the different onset of sexual maturity, the length composition varies. In May 1946, the average lengths of the sexes differ by 6.4 cm and in April and May 1957, by 3·8 cm. Normally, males are smaller than 40 cm. The largest female had a length of 58 cm.

The age composition of plaice is shown in Table 9.

When considering this it must be remembered that any age-group by 1. April increases its age by one year, viz., group I becomes group II. Bearing this in mind it can be established that most plaice now-

able 9. Age composition (%) of standard trawl catches nd of some commercial catches in the western Baltic

Date	Number of plaice	Age-groups 0	I	II	III	IV	V	V+
ommercial catches								
larch 1946	600	–	11·1	76·7	6·3	1·4	0·9	3·6
ct.-March 1952/53	347	–	43·7	25·1	20·5	6·9	1·5	2·3
pril/May 1957	120	–	–	48·4	28·1	23·5	–	–
tandard trawl catches								
lay 1956	37	–	–	30	46	24	–	–
ctober 1956	95	1	76	13	9	1	–	–
pril/May 1957	62	–	–	51	37	12	1	–

days belong to the II-group. Fluctuations determine nese variations. Evidently, the 1943, 1949, 1951, and 953 year-classes and especially the 1955 class, are elatively numerously represented. However, the naterial is too limited to warrent us to draw any onclusions.

Yield per hour

No data exist for the yields per effort of the commercial fishery, i.e., per ship or per hour. Only data elating to a few experimental hauls with the standrd trawl and occasional catches with a fishing boat re available.

Table 10. Number of plaice caught per hour in the western Baltic

Locality	Depth, m	Standard trawl May 1956		Oct. 1956		May 1957		Common trawl May 1957	
Fehmarnbelt	28	–		–		8·0	(1)	–	
Vejsnæs Rinne ..	29	2·0	(3)	2·0	(1)	3·0	(2)	4·4	(5)
of Langeland .	22	–		5·0	(1)	2·2	(5)	–	
Hohwacht Bay ..	19	2·8	(2)	26·7	(3)	3·6	(4)	3·3	(9)
Eckernförde Bay.	20	2·3	(4)	1·0	(6)	1·7	(6)	–	
Lübeck Bay	22	1·3	(4)	1·0	(2)	0	(1)	–	
Mean		2·1	(13)	7·3	(13)	3·8	(19)	3·6	(14)

The yield per hour is 3.6 or 3.8 plaice only. The results of both trawls (18 mm mesh size) agree.

The quality of the plaice

The length/weight index fluctuates considerably, depending on the nutritional condition and maturity. This fact must be remembered when considering Table 11.

Table 11. Length/weight index (k) of plaice from the Kiel Bay

Date	Number	Sex	Maturity	Length, cm	k
Dec./March 1952/53	78	♀	maturing	32–56	1·28
May 1957	55	♀	juvenile	21–31	1·17
May 1957	76	♂	juvenile	17–36	1·15

In May 1957, most of the plaice investigated belonged to age-group II. Male individuals had a length/weight index of 1.15, 1.17 for females, varying between 0.94 and 1.26. In May these values are normal. On the other hand, in summer they increased, on account of the better feeding conditions. The value for mature females was nearly 1.3. After spawning, the length/weight index fell to 1.0 or lower.

Immature plaice (126 in number) of both sexes from 21 to 31 cm long were investigated to ascertain the relation between *girth and length*. The following linear relation is the result:—

$$G = 0.97 \times L \text{ for male}$$
$$G = 0.95 \times L \text{ for female}$$

II. Baltic Proper

The yield from the Bornholm Deep, landed in Schleswig-Holstein, is rather small on account of the long distance between these areas. Fishermen especially fish for cod and herring, but only occasionally for flatfish. Statistical data are as follows:—

Year	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956
Tons	5	21	29	6	7	17	11	12	90	47

During 1950 the yield of plaice has been small, parallel to the decrease in the fishery for cod. In 1955 considerable increase was recorded for the first time.

Table 12. Length and age composition of two commercial catches from the Bornholm Deep in April and May 1957

Length, cm	Age-group III ♂	III ♀	IV ♂	IV ♀	V ♂	V ♀	Total ♂	Total ♀
22.....	1	–	–	–	–	–	1	–
23.....	–	1	–	–	–	–	–	1
24.....	1	–	–	–	–	–	1	–
25.....	6	–	1	–	–	–	7	–
26.....	4	–	–	–	–	–	4	–
27.....	7	1	1	–	–	–	8	1
28.....	9	–	3	–	–	–	12	–
29.....	5	–	3	–	–	–	8	–
30.....	1	–	7	–	–	–	8	–
31.....	1	–	6	2	1	–	8	2
32.....	–	1	7	1	–	–	7	2
33.....	1	2	5	5	–	–	6	7
34.....	–	–	2	2	–	–	2	2
35.....	–	–	2	5	–	–	2	5
36.....	–	–	–	5	–	1	–	6
37.....	–	–	–	3	–	1	–	4
38.....	–	–	–	2	–	–	–	2
39.....	–	–	–	–	–	1	–	1
40.....	–	–	–	–	–	2	–	2
41.....	–	–	–	1	–	–	–	1
Total ...	36	5	37	26	1	5	74	36
Mean length	27·7	30·3	31·5	35·5	38·9		29·6	35·2
♂ + ♀ ..	41		63		6		110	
%.....	37·3		57·3		5·4			

Table 13. Rate of growth of plaice in the western Baltic and the Baltic proper

Locality	Year	Average length of age-groups (in cm)									
		III		IV		V		VI		VII	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Bornholm Basin	1949	28·1	29·4	32·3	35·5	34·7	37·3	35·8	40·0	35·3	40·5
	1957	27·7	30·1	31·5	35·5	–	38·9	–	–	–	–
Kiel Bay (from V-gr. 1946) ..	1957	29·0	31·0	32·7	37·9	–	40·6	–	43·3	–	42·8

The monthly yields in tons were as follows:—

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
1955	3	15	29	8	14	9	2	1	1	1	5	3	90
1956	9	1	4	9	5	5	2	1	1	1	5	4	47
1957	3	13	15	8	2	1	–	–	–	–	–	–	(42)
Mean %	7	18	24	12	10	10	4	1	1	1	7	5	

The age composition of two commercial samples taken in Bornholm Deep in 1957 was as indicated in Table 12.

The sample is not representative for the stock. Yet it is clear that the III-group yields a great proportion of the catches. The absence of older plaice is perhaps an accident. A commercial sample taken in January 1949 consisted of 70 % plaice, older than 5 years.

Since 1949, the rate of growth has not changed materially, as can be seen in Table 13.

The growth of Bornholm plaice is somewhat slower than that of the western Baltic (Table 13).

B. Flounder (*Pleuronectes flesus* L.)

I. Western Baltic

1. Spawning

In 1957 spawning began early on account of the very mild winter. At the beginning of February most of the female flounders were maturing but only a few were spawning. In the middle of March spawning was in progress and it was finished by the end of April, as Table 14 shows.

Table 14.

Date 1957	♂♂ Maturity stages			♀♀		
	V	VI	VII	V	VI	VII
4. February	6	60	–	36	4	–
13. March ..	–	31	–	–	52	10
4. April ...	–	27	13	–	9	9
9. April ...	–	19	–	–	6	–
15. April ...	–	40	11	–	10	18
25. April ...	–	5	3	–	1	–
3. May ...	–	2	–	–	–	–
7. May ...	–	–	1	–	–	–
23. May ...	–	–	52	–	–	88

Regular hauls with the Hensen net from the lightvessel "Fehmarnbelt" give indications of the spawning time of the flounder. The following table gives the numbers of eggs/m² each month:—

Year	Feb.	March	Apr.	May
Mean 1935–43 ...	8	23	35	24
1953	–	1	26	6
1954	–	32	62	22
1955	–	1	52	3
1956	–	8	35	23
1957	–	32	3	–

This table also shows that spawning occurred at an early date in 1957. In March eggs are most plentiful, whilst the maximum spawning normally occurs in April. The average numbers of eggs have, however, decreased in recent years.

Our material is not sufficient to discover the favourite spawning places of the flounder. It spawns in deep water all over the western Baltic and also in the bays near the land (Eckernförde and Hohwacht Bays). On the other hand, no flounders were caught in the Fehmarnbelt in April 1957.

Table 15. Age composition of mature flounders (commercial catches)

Year	Locality	Age-groups									
		II		III		IV		V		VI	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
1946	Fehmarnbelt	–	–	124	38	52	42	5	7	1	3
	♂ + ♀	–		162		94		12		4	
	%	–		59·6		34·5		4·4		1·5	
1957	Kiel Bay	59	41	174	147	31	39	4	7	–	6
	♂ + ♀	100		321		70		11		6	
	%	19·7		63·2		13·8		2·2		1·2	

Table 16. Length and age composition of flounders in commercial landings from Kiel Bay in February to May 1957

Length, cm	Age-groups II ♂	II ♀	III ♂	III ♀	IV ♂	IV ♀	V ♂	V ♀	VI ♂	VI ♀	VII ♂	VII ♀	VIII + ♀	Total ♂	Total ♀
9	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–
0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–
2	9	1	2	–	–	–	–	–	–	–	–	–	–	11	1
3	14	10	9	2	–	–	–	–	–	–	–	–	–	23	12
4	14	15	4	2	–	–	–	–	–	–	–	–	–	18	17
5	7	12	11	3	–	–	–	–	–	–	–	–	–	18	15
6	3	1	29	5	–	–	–	–	–	–	–	–	–	32	6
7	4	1	20	13	3	–	–	–	–	–	–	–	–	27	14
8	4	1	20	27	2	–	–	–	–	–	–	–	–	26	28
9	–	–	28	24	5	–	–	–	–	–	–	–	–	33	24
0	–	–	19	17	3	1	–	–	–	–	–	–	–	22	18
1	–	–	15	16	1	2	–	–	–	–	–	–	–	16	18
2	–	–	5	14	5	4	1	1	–	–	–	–	–	11	19
3	–	–	4	6	4	7	–	–	–	–	–	–	–	8	13
4	–	–	3	4	6	5	–	–	–	–	–	–	–	9	9
5	–	–	1	6	2	6	–	1	–	–	–	–	–	3	13
6	–	–	1	4	1	1	1	–	–	–	–	–	–	3	5
7	–	–	–	–	–	1	3	2	–	–	–	–	–	3	3
8	–	–	–	–	–	4	–	1	–	–	–	–	–	–	5
9	–	–	–	–	–	2	–	–	1	–	–	–	–	1	2
0	–	–	–	–	–	–	–	3	1	–	1	–	–	2	3
1	–	–	–	–	–	1	–	1	–	–	–	–	–	–	2
2	–	–	–	–	–	–	–	2	–	1	–	–	–	–	3
3	–	–	–	–	–	–	–	1	–	1	–	–	–	–	2
4	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1
5	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1
6	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1
7	–	–	–	–	–	–	–	–	–	1	–	2	–	–	3
8	–	–	–	–	–	–	–	–	–	1	–	1	–	–	2
9	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1
otal	57	41	171	143	32	34	5	13	2	5	1	3	2	268	241
lean length, cm	♂24·5		28·4		31·9		36·3		40·0		40·5		–	28·3	
	♀24·7		30·2		35·0		39·8		45·7		47·8		48·0	31·1	
+ ♀	98		314		66		18		7		4		2	509	
	19·2		61·7		13·0		3·5		1·4		0·8		0·4	–	

Just like the plaice, the flounders caught in March/ lay by the trawl were all mature fish. There were a ale of 19 cm and a female of 22 cm, both belonging group II. A great proportion of this age-group awned in the spring of 1957. Table 15 shows the ge composition of the stock of mature flounders in e Fehmarnbelt (March 1946) and in Kiel Bay March to May 1957).

Most of the mature flounders are 3 years old, but ature flounders of the II-group are more numerous an those of the IV-group. The age-group II was sent in 1946 (Fehmarnbelt), as this sample was om a commercial catch. The average age of mature ounders is remarkably low. At present it amounts to 0 years for the flounder and 2.8 years for the plaice. spring 1946, immature female flounders were und up to a length of 28 cm.

2. Growth

Table 16 gives the results of an age analysis, carried out on 509 flounders from Kiel Bay in February to May 1957. Comparison of the growth analysis between 1946 and 1957 shows an increase in growth (see Table 17). The growth-rate of the flounder in the western Baltic is almost as fast as that of the plaice (cf. Table 5).

3. Composition of the stock

Up to the 1920's, the annual yield of the flounder fishery was not high when compared with that of the plaice. From 1927 and onwards it increased and became considerably higher than the yield of the plaice fishery (see Table 5). Table 18 shows the yields of the flounder fishery in the western Baltic, landed in Schleswig-Holstein.

Table 17. Average lengths (cm) of age-groups of flounders

Year	II		III		IV		V		VI		VII	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
1946	–	–	27·4	29·7	30·0	33·3	33·7	37·7	36·0	41·5	–	–
1953	23·7	25·0	27·3	29·4	30·8	34·1	34·3	38·1	37·1	40·4	38·5	42·5
1957	24·5	24·7	28·4	30·2	31·9	35·0	36·3	39·8	40·0	45·7	41·5	47·8

Table 18. Yields of the German flounder fishery in the western Baltic

Year	Tons	Average for 5 years	
		1925/29	96
		1930/34	163
		1935/39	163
		1940/44	136
1945	80		
1946	155		
1947	46	1945/49	133
1948	92		
1949	291		
1950	152		
1951	190		
1952	184	1950/54	159
1953	125		
1954	146		
1955	223		
1956	349	1955/56	286

In 1955 and 1956 the landings increased considerably. The landings of flounder are more uniformly distributed over the year than the landings of plaice. Yet in the spring big catches are made because of the spawning time. Thus the first 5 months provide almost 60 % of the yields for the year, if we disregard the years 1950, 1953, and 1954 since in these years, the close period was strictly observed. Table 19 shows the landings from the western Baltic in tons per month in the period from 1946 to 1957.

It can be seen that in the years with a close period the weight yields are lower than in the other years, as the reduction in yields in February and March cannot be compensated for by better catches in the following months.

The length distributions and average lengths (Table 20) have not changed materially when compared with the former years. In March 1946 almost the same length compositions and average lengths (males 28.2 cm, females 32.0 cm) were found. Table 21 gives the percentage age composition of flounder, taken by the standard trawl in 1956 and 1957. As these samples were very small they are compared with commercial catches of 1946, 1953, and 1957.

Table 20. Length distribution of experimental catches in 1956 and 1957

Length groups, cm	May 1956		Oct. 1956		February/April 1957					
	No.	%	No.	%	No.	%	No.	♂ %	No.	♀ %
16–20	–	–	–	–	1	–	1	–	–	–
21–25	–	–	–	–	52	14	43	20	9	6
26–30	2	33	5	56	171	46	119	55	52	34
31–35	4	66	3	33	106	29	44	21	62	40
36–40	–	–	1	11	25	7	8	4	17	11
41–45	–	–	–	–	10	3	1	–	9	6
46–50	–	–	–	–	5	1	–	–	5	3
Mean length, cm	32·3		31·1		30·6		28·9		32·9	

Table 21. Age composition of flounders in catches with standard trawl compared with samples from commercial catches (age-groups in Feb./Mar. taken as compl.)

Date	Number of plaice	Age-groups				
		II	III	IV	V	VI
Commercial catches:						
March 1946	272	–	60	35	4	1
March 1953	334	12	23	22	21	10
Feb./May 1957	200	6	64	20	7	3
Standard trawl catches:						
May 1956	6	–	33	33	33	–
Oct. 1956	9	33	56	11	–	–
Feb./May 1957	32	28	50	13	6	3

Table 19. Monthly landings of flounders from the western Baltic in tons

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
1949	15	60	67	13	10	6	12	18	24	29	28	9	291
1950	25	–	–	24	16	10	7	10	13	20	16	11	152
1951	36	32	20	15	7	8	10	15	12	13	14	8	190
1952	34	30	25	25	9	8	7	8	9	11	10	8	184
1953	20	–	–	14	5	4	7	11	20	20	15	9	125
1954	27	–	1	24	15	10	10	9	10	14	14	12	146
1955	33	40	18	22	15	16	10	7	13	19	15	15	223
1956	41	11	25	48	38	21	16	26	36	37	29	21	349
1957	44	85	35	36	23	18	20	–	–	–	–	–	(261)
Mean of 1950, 53, 54 in %	17	–	–	15	8	16	16	7	10	13	11	7	
Mean of remaining years in %	13	14	13	10	6	5	4	6	7	9	8	5	

In the years mentioned most of the flounder belonged to age-group III, followed by groups II and V. At present the proportion of the older age-groups amounts to only 10 % .Thus the age distribution of the flounder catches is not unsatisfactory, since the fishery depends on four age-groups.

. Yield per hour

The yields of flounder obtained with the standard trawl were very small, and accordingly no calculation of the average numbers caught per hour has been made. On the other hand, a commercial fishing vessel yielded 11 flounders per hour (calculated on 28 samples taken in May 1957).

. Quality of the flounder

The length/weight index fluctuated widely, as only maturing and spent individuals were investigated.

Table 22. Length/weight index of maturing and spent flounder from Kiel Bay

(In brackets values of variation)

Date	Number	Maturity	Length, cm	Length/Weight index	
Dec./March 1952/53	61	IV–V	26–51	1·39	– –
May 1957	54	VII	22–40	1·09	(0·94–1·23)
May 1957	43	VII	22–34	1·07	(0·89–1·21)

Within the same nutritional condition, the length/weight index falls off with increasing length. The relation between length and girth was established for spawned individuals only. A small but characteristic difference between the sexes was found. The linear relation between length and girth for the flounder is as follows:—

$G = 0.89 \times L$ (43 individuals) for male, and
$G = 0.90 \times L$ (54 individuals) for female.

The data fluctuate individually very widely.

II. Baltic Proper

In the Bornholm Deep flounders are caught only occasionally, as was the case with the plaice.

Year	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956
Tons	5	47	97	13	17	23	15	5	40	34

The quantities are small, and, since 1954, less than the landings of plaice, in consequence of the different behaviour of the fish after spawning. Flounders return to shallow water whereas plaice remain to a certain extent in the deep water of the Bornholm Basin.

Table 23 gives the monthly landings (tons) from the Baltic proper in 1955 to 1957.

The majority of flounders are caught in the first months of the year. In 1957 the yields have risen considerably. The age determinations of two commercial samples from Bornholm Deep taken in April and May 1957 are given in Table 24.

Table 24. Length and age composition of flounders in two commercial catches from the Bornholm Deep in April and May 1957

Length, cm	Age-groups III ♂	III ♀	IV ♂	IV ♀	V ♂	V ♀	VI ♂	VI ♀	Total ♂	Total ♀
20	–	–	1	–	–	–	–	–	1	–
21	3	–	–	–	–	–	–	–	3	–
22	10	–	4	–	–	–	–	–	14	–
23	4	1	8	1	–	–	–	–	12	2
24	7	1	18	4	1	–	–	–	26	5
25	5	2	22	5	1	1	–	–	28	8
26	2	2	23	5	1	–	–	–	26	7
27	3	6	18	11	3	1	–	–	24	18
28	–	3	12	13	4	5	–	–	16	21
29	2	–	12	14	–	1	–	–	14	15
30	–	–	5	6	3	1	–	–	8	7
31	–	–	6	4	1	1	–	–	7	5
32	–	–	2	7	1	4	1	–	4	11
33	–	–	–	3	2	4	–	–	2	7
34	–	–	–	1	–	2	–	–	–	3
35	–	–	–	2	–	5	–	2	–	9
36	–	–	–	–	–	3	–	2	–	5
37	–	–	–	–	–	3	–	–	–	3
38	–	–	–	–	–	2	–	4	–	6
39	–	–	–	–	–	–	–	1	–	1
40	–	–	–	–	–	–	–	–	–	–
41	–	–	–	–	–	–	–	1	–	1
42	–	–	–	–	–	–	–	1	–	1
43	–	–	–	–	–	–	–	–	–	–
44	–	–	–	–	–	–	–	1	–	1
Total	36	15	131	76	17	33	1	12	185	136
Mean length	24·4	26·8	26·8	29·1	29·1	33·2		38·8	26·6	30·4
♂ + ♀	51		207		50		13		321	
%	15·9		64·5		15·6		4·0			

Since 1952/53 the average lengths of the age-groups have not changed. They are 5—6 cm smaller than those in the western Baltic. That is more than the growth of one year. The fish belong mostly to age-groups IV and V and some also to the III-group. Flounder, older than age-group V, are not very numerous.

Table 23. Monthly landings (tons) of flounders from the Baltic proper

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
1955	2	7	6	11	9	2	1	0	0	0	1	1	40
1956	9	2	2	8	6	1	1	1	1	0	1	2	34
1957	12	46	25	23	11	1	1	–	–	–	–	–	(117)
Mean, %	12	27	16	21	13	3	2	1	1	1	1	2	

C. Dab (*Pleuronectes limanda* L.)

I. Western Baltic

In consequence of the decline of the stock of flatfish in the Baltic, the growth-rate of the dab has increased considerably and the fish attain larger sizes than ever before. This species is therefore now of some economical importance.

The age and length compositions of various samples from Kiel Bay are given in Table 25.

Comparing the results from Table 25 with former investigations, we must take into consideration that in 1946 and 1952/53 the samples of commercial catches analysed, contained very few individuals under 20 cm in length. From Table 25 it can be seen that a considerable part of the III-group is less than 20 cm long. It is therefore possible only to determine the average length of age-group IV and older in the commercial catches.

Table 26 shows a further increase in growth since 1946.

In the period 1938 to 1946, the average length of age-groups II and III rose by 1—3 cm and age-group IV by 5—6 cm. In the last 10 years they have further increased by 1 to 2 cm.

Owing to the overlapping size variations of the eggs

Table 25. Length and age composition of dab in catches with the standard trawl in Kiel Bay from February to May 1957

Length, cm	Age-groups II		III		IV		V		VI		Total	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
10	3	1	–	–	–	–	–	–	–	–	3	1
11	3	2	–	–	–	–	–	–	–	–	3	2
12	5	10	–	1	–	–	–	–	–	–	5	11
13	18	14	2	–	–	–	–	–	–	–	20	14
14	20	22	3	2	–	–	–	–	–	–	23	24
15	39	20	7	6	–	–	–	–	–	–	46	26
16	43	25	22	13	–	–	–	–	–	–	65	38
17	26	25	36	33	–	–	–	–	–	–	62	58
18	28	19	76	46	–	–	–	–	–	–	105	65
19	26	13	97	69	2	–	–	–	–	–	125	82
20	10	10	103	71	3	1	–	–	–	–	116	82
21	3	11	105	101	5	–	–	–	–	–	113	112
22	1	6	111	79	6	–	–	–	–	–	118	85
23	–	4	66	79	7	2	–	–	–	–	73	85
24	–	3	57	91	6	3	–	–	–	–	63	97
25	–	2	52	64	10	6	1	–	–	–	63	72
26	–	1	31	49	10	7	2	–	–	–	43	57
27	–	1	38	37	11	19	3	1	–	–	52	58
28	–	–	4	28	16	18	2	–	–	–	22	46
29	–	–	3	16	16	22	3	1	–	–	22	39
30	–	–	1	8	6	20	1	2	–	–	8	30
31	–	–	–	2	1	19	3	8	–	–	4	29
32	–	–	–	1	1	6	2	5	2	–	5	12
33	–	–	–	–	–	7	–	7	–	1	–	15
34	–	–	–	–	–	2	–	3	–	–	–	5
35	–	–	–	–	–	–	–	1	–	–	–	1
36	–	–	–	–	–	–	–	2	–	–	–	2
37	–	–	–	–	–	–	–	1	–	–	–	1
Total	225	189	814	797	101	132	17	30	2	1	1159	1149
Mean length, cm	16·8	17·7	22·0	23·1	26·4	29·3	29·2	33·7	32·5	33·5		
♂ + ♀	414		1611		233		47		3		2308	
%	17·9		69·9		10·1		2·0		0·1			

Table 26. Mean length of age-groups of dab, in the western Baltic, 1946 to 1957

Year	Sample	Age-groups II		III		IV		V		VI	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
1946	Commercial	–	–	23·1	24·5	26·2	28·5	29·5	31·7	30·0	34·5
1947	Biological	15·5	15·8	20·8	22·0	–	–	–	–	–	–
1953	Commercial	–	–	25·1	26·5	28·3	30·9	–	34·6	–	39·0
1957	Biological	16·0	17·7	22·0	23·1	26·4	29·3	29·2	33·7	–	–

Table 27. Number of eggs of dab per m² in the Fehmarnbelt

Year	May	June	July	August
Average 1935–43	35	18	3	–
1953	4	19	10	1
1954	10	28	8	–
1955	1	12	15	–
1956	12	18	3	–

of the flounder and the dab, the beginning of the spawning period of the latter cannot be exactly determined. Therefore the number of eggs caught in the Fehmarnbelt in May were apportioned between the two species according to their number of eggs in April and June. The values for recent years are set out in Table 27.

Table 28. The German dab fishery in the western Baltic

Year	Tons	Average for 5 years	
		1925/29	165
		1930/34	257
		1935/39	210
		1940/44	108
1945	93		
1946	97		
1947	35	1945/49	74
1948	55		
1949	88		
1950	172		
1951	197		
1952	217	1950/54	215
1953	229		
1954	259		
1955	260		
1956	235	1955/56	248

Table 29. Comparison of the landings from the western Baltic of flatfish species in the period 1925 to 1956

Year	Plaice		Flounder		Dab		Turbot		Total
	Tons	%	Tons	%	Tons	%	Tons	%	Tons
1925/29	161	36	96	21	165	36	31	7	453
1930/34	116	21	163	30	257	48	6	1	542
1935/39	62	14	163	37	210	48	4	1	439
1940/44	35	12	136	48	108	39	2	1	281
1945/49	40	16	133	53	74	30	3	1	250
1950/54	96	20	159	34	215	45	5	1	475
1955/56	145	21	286	42	248	36	6	1	685
Mean %		20		38		40		2	

Table 30. Monthly German landings of dabs from the western Baltic

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total tons
1949	9	11	7	4	1	2	3	7	10	9	13	12	88
1950	18	17	21	12	9	7	5	8	8	18	22	27	172
1951	35	34	17	9	5	5	7	10	12	19	15	29	197
1952	28	28	18	11	5	10	7	6	6	26	33	39	217
1953	40	25	18	13	7	7	7	13	14	20	22	43	229
1954	39	13	20	21	13	9	9	11	15	19	34	56	259
1955	52	30	19	14	17	8	6	13	18	16	32	35	260
1956	37	5	12	22	13	8	9	5	15	23	46	40	235
1957	34	31	24	12	13	6	8	–	–	–	–	–	(128)
Mean %	16	10	8	6	4	3	3	5	6	9	13	17	–

Table 31. Length composition of the stock of dabs in the western Baltic in experimental hauls with the standard trawl in 1956 and 1957

Length groups, cm	May 1956		Oct. 1956		April–May 1957		♂♂		♀♀	
	Number	%	Number	%	Number	%	Number	%	Number	%
8–10	6	1	33	4	4	–	3	–	1	–
11–15	656	38	96	12	174	7	97	8	77	7
16–20	649	38	460	57	798	35	473	41	325	28
21–25	225	13	199	24	891	39	430	37	451	39
26–30	138	8	28	3	377	16	147	13	230	20
31–35	32	2	2	–	71	3	9	1	62	6
36–37	–	–	–	–	3	–	–	–	3	–
Mean length	18·3		19·2		22·1		21·3		23·0	

In general, the eggs of the dab are scarcer than those of the flounder, and the quantity has decreased. But from our plankton hauls, especially in July, we know that a great many dab larvae are transported from the northern Belt Sea into Kiel Bay by the bottom current.

The annual landings were low in 1940 to 1949, caused by the special circumstances during the war and afterwards, but after 1950 again reached the average from 1930 to 1939 (see Table 28).

The dab is the predominant flatfish species (see Table 29). The proportion of plaice has diminished from 36 % to 21 %, whereas that of the flounder rose from 21 to 42 %. The values for the dab fluctuate, but on the whole it has remained remarkably constant. The turbot is of very little importance.

The majority of dabs are landed in autumn and winter (see Table 30). In contrast to plaice and flounder, the largest quantities are not fished during the spawning time, but in winter when the dabs are in good condition. During the spawning period (May-July) only 10 % of the annual yield is landed. It is remarkable that the dab has reached and maintained its economical importance without any protective measures.

The fishermen only bring dabs larger than 20 cm in length to the market. In our experimental hauls, a large proportion of the dabs were smaller than this usual minimum size, in May 1956, 77 %, in April and May 1957, 42 %. The average length increases from 18·3 cm in May 1956 to 19·2 cm in October 1956 and to 22·1 cm in May 1957, i.e., an increase of 3·8 cm, indicating a considerable fluctuation in the age composition.

The length of the dabs caught by the standard trawl (see Table 31), is much lower than that of the plaice and flounder; in April and May 1957 the difference amounted to 7·5 cm in relation to plaice, and 8·5 cm to flounder. The maximum length of the dab does not exceed 40 cm. Young dabs exhibit a greater preference for deep water than do young plaice and flounders.

Samples from commercial landings in 1946—53 contain only dabs aged 3 years and up (over 20 cm in length). In the experimental hauls from 1956 and 1957, the maximum values shift from the II-group in 1956 to the III-group in 1957 (see Table 32). These groups are represented by the 1954 year-class, which proved to be a rich one, whereas the following 1955 year-class was much poorer, representing only 14 % of the catch as I-group in October 1956, and as II-group in May 1957. Similar percentages have been found for the 1953 year-class (age-group III and IV, respectively). Older age-groups were relatively rare.

Table 32. The age composition of experimental hauls and of various samples from commercial trawling

Date	No. of dabs	Age-groups (%)					
		I	II	III	IV	V	VI
Commercial catches:							
March 1946....	729	–	–	29	40	15	12
Nov./March 1952/53	142	–	–	39	40	18	3
Standard trawl catches:							
May 1956....	1730	–	73	17	7	2	1
Oct. 1956....	818	14	78	6	2	–	–
April/May 1957....	1202	–	14	72	11	3	–

Table 33. Number of dabs per hour's fishing with the standard trawl in the western Baltic

(Number of hauls shown in brackets)

Locality	Depth, m	Number per hour's fishing					
		May 1956		Oct. 1956		May 1957	
Fehmarnbelt.....	28	–		–		63	(1)
Vejsnæs Rinne.....	29	100	(3)	93	(1)	68	(7)
S of Langeland	22	–		94	(1)	19	(5)
Hochwachter Bay ..	19	123	(2)	76	(3)	63	(13)
Eckernförder Bay ..	20	101	(4)	39	(6)	15	(6)
Lübecker Bay	22	57	(4)	87	(2)	6	(1)
Mean.....		95	(13)	78	(13)	47	(23)

The average number of dabs obtained per hour's fishing in May 1957 was only half of that obtained in May 1956 (see Table 33). Compared with these quantities the number of plaice was only one-tenth and less, and that of flounder still less.

Table 34. Relationship between length and girth in April and May 1957

Length, cm	Average girth, cm			
	Males		Females	
12.....	–	–	9·3	(3)
13.....	9·8	(4)	11·0	(3)
14.....	11·0	(3)	11·3	(4)
15.....	12·0	(6)	11·7	(3)
16.....	13·0	(8)	13·3	(4)
17.....	14·1	(14)	14·2	(12)
18.....	14·7	(15)	15·1	(11)
19.....	16·2	(16)	15·8	(12)
20.....	17·0	(23)	16·6	(11)
21.....	17·9	(19)	18·1	(17)
22.....	18·8	(20)	19·2	(12)
23.....	20·0	(13)	20·2	(19)
24.....	20·6	(9)	21·2	(19)
25.....	21·5	(10)	22·0	(17)
26.....	22·7	(7)	23·2	(13)
27.....	23·0	(9)	24·4	(14)
28.....	25·2	(9)	25·2	(10)
29.....	25·9	(8)	26·7	(11)
30.....	26·2	(3)	26·4	(8)
31.....	27·5	(2)	27·4	(7)
32.....	29·0	(2)	28·6	(8)
33.....	–	–	30·6	(5)
34.....	–	–	28·5	(2)
36.....	–	–	33·0	(1)

The length/weight index is close to 1·0 under normal conditions and increases to 1·2 for mature fish, as may be seen from the following table:—

Year	Month	Number	Sex	Maturity	Length, cm	Length/Weight index
1953	April	117	♀	IV–V	23–40	1·20 (1·00–1·49)
1957	May	226	♀	III–IV	12–36	1·09 (0·83–1·21)
1957	May	196	♂	III–IV	13–32	1·01 (0·91–1·07)

The relation between length and girth was determined for 200 males and 226 females, measuring from 12 to 36 cm in April and May 1957. The results are given in Table 34 (numbers in brackets).

As for plaice and flounder, we obtained a linear relationship between length and girth for the dab also, according to the following formulae:—

Males $G = 0.85 \times L$
Females $G = 0.86 \times L$

Comparing the quotient G/L for the three species of flatfish, we find that the body of the plaice is the highest (0·96), that of the flounder more slender (0·90), and that of the dab more slender still (0·85). This provides a numerical statement for the appearance of each species.

II. Baltic Proper

Dabs are landed from the fishing grounds in the Bornholm area, together with plaice and flounders. The quantities since 1947 are as follows:—

Year	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956
Tons	5	47	97	13	17	23	15	4	14	8

As the cod fishery in the Bornholm Basin decreased, the landings of dabs decreased also and are now below those of plaice and flounder. Age determinations have not been carried out in recent years.

D. Cod (*Gadus callarias* L.)

The increase in the stock of cod in the third decade of this century was the most astonishing phenomenon. In consequence of the decline in the stock of flatfish, the fishery exploited more and more the rich shoals of cod, which apart from the herring has now become the most important food fish in the Baltic. An interesting question is, whether the growth-rate of the cod has altered in consequence of the greater density of the stock.

I. Western Baltic

The otoliths collected from cod of the western Baltic are quite readable, in contrast to many otoliths of cod from the central Baltic. The length and age compositions of samples taken in April and May 1957 in Kiel Bay are given in Table 35 (age-group I = 1956 year-class).

In the length distributions three peaks, at 18, 32–34, and 44 cm, corresponding to the mean length of age-groups I-III, can be seen.

The results from Table 35 compared with those obtained in former years are shown in Table 36.

From 1931 to 1946 we observe a distinct decrease in the growth-rate of cod older than 4 years. The difference in mean lengths rise to 11 cm in the VI-group. In 1946 the average length of age-groups II and III were higher, owing to the selective action of the commercial trawl. This decrease in growth was caused perhaps, by the increase in the stock. Several fish of more than 60 cm length showed alterations in body proportions, probably in consequence of bad nourishment (Lühmann, 1954).

Our investigations in 1957 show a renewed increase in growth-rate of the cod, which may be regarded as an indication of a reduction in the stocks. Whereas the quantity of cod eggs in the Fehmarnbelt increased considerably until 1938, it decreased gradually from that year as can be seen from the data obtained in recent years:—

Number of cod eggs per m² in the Fehmarnbelt

Year	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
1935–43	4	15	81	49	24	3	1
1953	–	28*)	2	7	19	4	–
1954	2	0·5	8	15	37	3	1
1955	35*)	5	4	83	59	5	–
1956	–	0·5	–	12*)	28	12	2
1957	2*)	–	14	13	4	1	–

*) Second half of month.

Table 36. Average lengths of age-groups of cod, western Baltic (cm)

Year	Sample	Number	Age-groups I	II	III	IV	V	VI	VII
1931–38	Biological	283	14·5	23·6	37·5	52·9	68·1	72·7	78·9
1946–49	Commercial	1234	–	29·8	40·8	50·0	57·1	61·7	–
1957	Biological	2084	18·8	32·8	43·5	52·5	59·6	67·3	67·4

Table 35. Length and age composition of cod in catches with the standard trawl in Kiel Bay in April and May 1957

Length, cm	Age-groups I	II	III	IV	V	VI	VII	Total
10....	1	–	–	–	–	–	–	1
12....	5	–	–	–	–	–	–	5
14....	18	–	–	–	–	–	–	18
16....	64	–	–	–	–	–	–	64
18....	89	–	–	–	–	–	–	*89*
20....	51	–	–	–	–	–	–	51
22....	46	–	–	–	–	–	–	46
24....	21	–	–	–	–	–	–	21
26....	8	28	–	–	–	–	–	36
28....	4	80	–	–	–	–	–	84
30....	–	135	–	–	–	–	–	135
32....	–	198	–	–	–	–	–	198
34....	–	194	9	–	–	–	–	*203*
36....	–	150	39	–	–	–	–	189
38....	–	68	71	–	–	–	–	139
40....	–	6	98	–	–	–	–	104
42....	–	–	114	–	1	–	–	115
44....	–	–	140	1	–	–	–	*141*
46....	–	–	104	5	1	–	–	110
48....	–	–	70	21	–	–	–	91
50....	–	–	57	12	2	1	1	73
52....	–	–	21	27	–	–	–	48
54....	–	–	7	14	6	–	–	27
56....	–	–	1	13	6	–	–	20
58....	–	–	1	7	5	–	–	13
60....	–	–	–	4	8	–	1	13
62....	–	–	–	2	3	3	–	8
64....	–	–	–	1	2	2	–	5
66....	–	–	–	–	2	4	1	7
68....	–	–	–	–	2	–	–	2
70....	–	–	–	–	1	3	–	4
72....	–	–	–	–	1	1	1	3
74....	–	–	–	–	2	3	2	7
76....	–	–	–	–	–	2	1	3
78....	–	–	–	–	1	–	–	1
101....	–	–	–	–	–	–	IX	1
Total..	317	857	733	107	43	19	8	2,084
%.....	15·2	41·1	35·2	5·1	2·1	0·9	0·4	
Average length..	18·8	32·8	43·5	52·5	59·6	67·3	67·4	

In mild winters, the spawning of the cod begins in December and lasts to May or June, showing a maximum in February or March. In severe or prolonged winters, the main spawning time shifts to March or even April, as in 1954 and 1956. Sometimes spawning is interrupted for one or two months by a sudden onset of severe frost. In 1957, the number of cod eggs was extremely low.

Table 37. The German cod fishery in the western Baltic since 1925 (landings in Schleswig-Holstein)

Year	Tons	Average for 5 years	
		1925/29	1735
		1930/34	1838
		1935/39	2150
		1940/44	3464
1945	5044		
1946	5603		
1947	4288	1945/49	5532
1948	7351		
1949	5372		
1950	5135		
1951	5547		
1952	6380	1950/54	5507
1953	5591		
1954	4883		
1955	5649		
1956	4949	1955/56	5299

The catch of cod in the western Baltic showed a very remarkable increase from less than 2000 tons to about 5000 tons in recent years with maximum landings in 1948 and 1952 (see Table 37). The cod is fished throughout the year, but in the summer the market is poor and, therefore, landings in the months April to September are relatively small. On the other hand, the concentration of the shoals in deeper water on the spawning grounds in the winter months favours the catch of large quantities (Table 38).

Investigations on *size and age composition of the stock* were carried out by means of material obtained by experimental fishing with a standard trawl in 1956 and 1957 (Tables 39 and 40).

Small cod, below 30 cm, represent a considerable part of the catches, which fluctuate according to season and strength of the year-classes. The length distributions and the average lengths therefore vary to

Table 38. Monthly German landings of cod from the western Baltic (tons)

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
1949.....	1085	1040	545	210	250	155	282	301	287	431	412	369	5367
1950.....	646	482	389	271	145	92	214	233	375	506	497	585	4435
1951.....	783	739	384	245	134	109	224	290	347	525	350	608	4738
1952.....	935	1027	583	468	213	351	206	292	300	538	512	502	5927
1953.....	775	527	385	326	147	99	228	243	375	448	488	648	4689
1954.....	655	401	486	214	238	138	161	237	243	377	473	550	4173
1955.....	896	685	454	166	271	183	231	363	368	331	455	487	4890
1956.....	816	181	722	391	193	204	228	241	359	553	551	510	4949
1957.....	810	673	386	224	312	316	448	–	–	–	–	–	(3169)
Mean %.....	17	13	10	6	4	3	4	6	7	9	10	11	

Table 39. Length composition of cod in the western Baltic

Length groups, cm	May 1956 Number	%	October 1956 Number	%	April/May 1957 Number	%
6–10	10	1·3	258	19·1	1	0·5
11–15	117	14·9	134	10·3	56	2·7
16–20	73	9·3	77	5·9	181	8·7
21–25	46	5·9	255	19·1	84	4·0
26–30	185	23·5	148	11·3	238	11·4
31–35	200	25·4	131	10·0	491	23·1
36–40	67	8·6	173	13·3	340	16·3
41–45	25	3·2	73	5·6	307	14·7
46–50	10	1·3	24	1·8	223	10·7
51–55	9	1·1	19	1·5	86	4·1
56–60	12	1·5	7	0·5	36	1·7
61–65	21	2·7	3	0·2	19	0·9
66–70	5	0·6	2	0·2	7	0·3
71–75	5	0·6	–	–	12	0·6
76–80	1	0·1	–	–	2	0·1
90	–	–	1	0·1	–	–
92	1	0·1	–	–	–	–
101	–	–	–	–	1	–
Total	787		1305		2084	
Mean length, cm	29·3		25·3		36·3	

a considerable extent. The mean length decreases from 29·3 cm in May 1956 to 25·3 cm in October because of the entry of the new 1956 year-class; it increases by 11 cm to 36·3 cm in April and May 1957, due to growth and alteration in the age distributions, as will be seen from Table 40.

Table 40. Age composition of cod in the western Baltic (%)

Month	Year	Number	Age-groups 0	I	II	III	IV	V	VI+
May	1956	787	–	24	34	24	11	2	5
October	1956	1305	30	36	24	7	2	1	–
April/May	1957	1128	–	16	40	36	5	2	1

Both in 1956 and 1957 age-groups I-III predominated, the proportions being different according to the strength of the year-classes. The frequency of older age-groups was low, as the effect of the fishery was very pronounced.

Yield per hour

The catch per hour was very different on the different grounds (see Table 41). In October the number of cod was $2^1/_2$ times of that in spring. The best catches were obtained in the Hohwacht Bay, a good fishing place for commercial fishing.

The length/weight index was calculated for 692 cod caught in April/May 1957. It varied between 0·84 and 1·05, with an average of 0·94 (see Table 42).

From this table and more clearly from Figure 1, it will be seen that the variation of k is regular and exhibits a distinct rhythm. The highest values of k coincide with the average length of age-group I, II, and approximately III. This may be explained on the assumption that the slow, as well as the fast growing individuals of an age-group are more slender than those of normal growth. For the whiting in the western Baltic we have observed a similar rhythmical fluctuation of the weight/length index from one age-group to another.

The relation between length and girth was determined for 600 fish measuring from 14 to 59 cm in length. The quotient G/L varies between 0·50 and 0·57 with an average of 0·54.

Table 41. Catches with the standard trawl on some fishing grounds in the western Baltic

Locality	Depth, m	Number of cod per hour's fishing: May 1956	October 1956	April/May 1957
Fehmarnbelt	28	– –	– –	71 (1)
Vejsnæs Rinne	29	36 (3)	161 (1)	5 (2)
S of Langeland	22	– –	58 (1)	29 (5)
Hohwacht Bay	19	88 (2)	134 (3)	126 (4)
Eckernförde Bay	20	11 (4)	83 (6)	10 (6)
Lübeck Bay	22	23 (4)	94 (2)	2 (1)
Mean		40 (13)	106 (13)	41 (19)

Table 42. Relationship between length (L) and weight/length index (k) for cod from the western Baltic

L	k	Number	L	k	Number	L	k	Number
14	1·05	3	29	0·92	16	44	0·91	15
15	1·02	5	30	0·97	22	45	0·95	21
16	1·00	4	31	1·01	22	46	0·87	20
17	0·93	6	32	1·03	21	47	0·92	17
18	1·04	5	33	1·05	24	48	0·90	18
19	0·99	4	34	1·03	23	49	0·92	20
20	1·05	7	35	0·98	24	50	0·88	13
21	0·95	8	36	0·99	26	51	0·90	11
22	0·94	5	37	0·97	14	52	0·86	11
23	–	–	38	0·98	21	53	0·87	11
24	–	–	39	0·97	14	54	0·86	5
25	0·92	7	40	0·94	22	55	0·87	5
26	0·90	6	41	0·98	24	56	0·85	4
27	0·93	14	42	0·94	22	57	0·89	2
28	0·92	22	43	0·96	26	58	0·90	2
						59	0·84	5

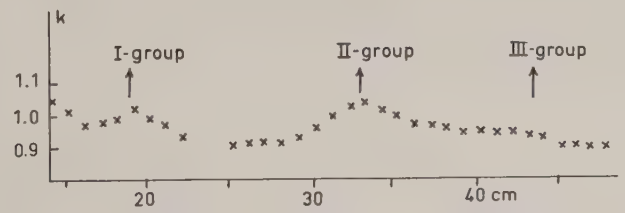

Figure 1. Relation between length and weight/length index.

Table 43. Average landings of cod per month in 1954 to 1956, according to market categories

Market category	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total	%
I	148	140	342	209	269	148	76	47	86	120	119	67	1771	63
II	49	57	130	98	91	49	28	17	40	57	61	30	707	25
III	20	26	81	30	41	21	13	7	10	26	29	23	327	12
Total	217	223	553	337	401	218	117	71	136	203	209	120	2805	
%	8	8	20	12	14	8	4	3	5	7	7	4		

II. Baltic Proper

In 1947 an intensive trawl fishery for cod in the Bornholm Basin started from the ports of Schleswig-Holstein. Many fishing cutters from the North Sea also took part in this very productive fishery, as the catches in the south-eastern North Sea were poor. The yields (tons) were as follows:—

Year	Schleswig-Holstein	North Sea harbours
1947	9,760	1,217
1948	17,050	13,461
1949	11,202	6,644
1950	4,555	2,721
1951	2,553	670
1952	3,410	143
1953	3,605	–
1954	3,111	–
1955	3,451	–
1956	3,066	–

The cod fishery in the Bornholm Basin reached its maximum in 1948 with about 31,000 tons. But the disposal of these large quantities of cod, partly of poor quality, was difficult and the landings decreased rapidly. In recent years the catch has been about 4,000 tons (including cod for industrial processing).

Table 43 shows the average landings per month in 1954 to 1956 according to market categories I-III.

The majority of the cod was caught from March to May, i.e., in the beginning of the spawning period. From June to August, the landings are poor. The main part of the catches is landed as market category I.

Appendix

As two years have passed since this report was prepared for the Baltic-Belt Seas Committee of ICES, the yields of the German fishery for flatfish and cod in 1957 and 1958 may be added to show the further development:

Area	Year	Plaice	Flounder	Dab	Cod
Western Baltic.	1957	119	468	210	6,137 tons
	1958	99	566	186	5,101 „
Baltic Proper . .	1957	56	122	9	8,235 „
	1958	52	74	5	6,711 „

The annual yields remained nearly constant, except those of flounders and cod which show a considerable rise in recent years.

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3.

The State of the South Baltic Flatfish Stock

(Material for consideration of flatfish protection)

By

Z. Mulicki

The Polish catches are composed of four species of flatfish, namely: flounder (*Pleuronectes flesus*), plaice (*P. platessa*), dab (*P. limanda*), and turbot (*Rhombus maximus*). The distribution of these species in the catches is subject to considerable fluctuations in different years and depends on the location of the fishing ground.

The flounder dominates the catches in all the regions of the southern Baltic, but this domination over the plaice, however, diminishes westwards, and the two remaining species are of no great importance. In the eastern region the turbot made up 4 % of the catches and the dab 1 % (mean values for 1954 to 1956). The brill, *Rhombus laevis,* is found in the westernmost regions. The relationship between the catches of the different species from 1954 to 1956 was as follows:—

Region	Species	Year			
		1954	1955	1956	1954–56
Gdańsk	Flounder	64	68	94	75
	Plaice	26	30	5	20
	Dab	2	1	+	1
	Turbot	8	1	1	4
	Total ...	100	100	100	100

Region	Species	Year			
		1954	1955	1956	1954–56
Bornholm	Flounder	45	42	55	47
	Plaice	55	52	43	50
	Dab	–	6	1	2
	Turbot	–	+	1	1
	Total ...	100	100	100	100

Only those species which are of the greatest economical importance will be discussed here. They are: the flounder, the plaice, and the turbot.

On biological and commercial grounds two basic areas can be recognized, i.e., the eastern or Gdańsk region, and the western or Bornholm region, together with the Pomeranian Bay.

It can be assumed that the eastern sill of the Słupsk Furrow and its extension towards the south is the boundary between these two areas. This boundary line is justified because it runs along a distinct and considerable elevation of the bottom, which separates the Gothland-Gdańsk basin from the west in a natural way.

I. Statistics of the Polish Flatfish Catches in the Baltic

In the period 1930 to 1938 the total Polish annual catches in the Baltic amounted to an average of 840 tons reaching a maximum of 1,116 tons in 1937.

Catches in the post-war years 1946 to 1956 were as follows:—

Year	1946	1947	1948	1949	1950
Tons	843	776	564	656	750
%	100	92	67	78	89

Year	1951	1952	1953	1954	1955	1956
Tons ...	630	664	717	1,317	1,787	1,200
%	75	79	85	156	212	142

It can be seen that there was a decline in the catches in the years 1946 to 1948; they were then uniform until 1953 and amounted to about 80 % of those of 1946. The catches in 1954 showed a considerable increase and reached a peak in 1955, when they were more than double that of 1946. In the next year the yields were poorer, although they were still quite good.

The yields in the different regions (in tons) during the last five years were as follows:—

Region	Year					%
	1952	1953	1954	1955	1956	
Gdańsk	424	525	872	1336	812	70
Western.....	240	192	445	451	338	30
Total...	664	717	1317	1787	1200	100

Table 1. Polish catches of flatfish in 1946–1954 as percentages

Month	Year											
	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1946–1956
I	2·5	7·0	5·5	6·5	1·5	4·5	2·0	4·5	2·0	4·3	6·0	4·2
II	2·5	0·5	10·0	3·5	2·0	3·5	8·5	4·5	2·0	6·4	3·2	4·2
III	0·5	0·5	3·0	3·5	4·5	2·5	12·0	6·0	8·5	7·1	11·2	5·4
IV	4·0	4·5	16·5	6·5	8·0	11·0	10·5	11·5	3·5	4·6	12·2	8·4
V	7·5	11·5	9·0	9·0	9·0	8·5	7·0	6·5	7·0	10·7	14·5	9·1
VI	20·0	19·5	13·0	4·0	6·0	17·5	10·0	11·5	5·5	16·0	9·0	12·0
VII	9·5	12·0	4·5	4·5	9·0	5·0	6·0	4·0	3·0	7·1	4·3	6·4
VIII	7·0	8·0	4·0	6·5	14·0	8·5	4·0	6·5	9·5	8·2	6·4	7·5
IX	8·0	9·5	5·0	11·5	10·5	10·0	6·0	6·5	12·0	9·1	5·1	8·5
X	10·0	7·5	7·5	9·5	5·5	11·0	10·0	9·0	16·0	7·1	8·1	9·2
XI	17·0	15·0	10·0	23·0	19·5	12·0	15·0	16·5	18·5	14·5	14·0	15·9
XII	11·5	4·5	12·0	12·0	10·5	6·0	9·0	13·0	12·5	4·9	6·0	9·2
%.....	100	100	100	100	100	100	100	100	100	100	100	100

Table 2. The yield of flatfish per cutter/day (kg) for 17 m cutters in 1953–1955

Base	Kołobrzeg			Darłowo			Ustka			Gdynia			Mean
Month	1953	1954	1955	1953	1954	1955	1953	1954	1955	1953	1954	1955	1953-1955
I	7	18	87	9	7	34	3	3	17	5	10	15	19
II	11	37	93	2	17	29	9	4	44	3	7	22	23
III	25	75	67	5	19	56	18	10	55	3	18	17	31
IV	32	28	18	23	6	28	4	11	44	13	8	18	19
V	8	6	4	–	1	6	5	8	18	1	2	6	5
VI	8	1	–	–	–	–	1	–	2	1	1	17	3
VII	2	–	–	–	–	–	–	–	–	–	1	1	–
VIII	1	–	–	–	–	–	–	–	–	1	3	1	0·5
IX	–	4	–	–	–	–	–	–	1	1	1	8	1
X	–	25	–	–	–	–	–	–	1	–	6	11	4
XI	1	106	20	–	6	18	–	7	9	–	7	18	14
XII	6	45	59	1	30	21	1	9	43	3	11	34	22
Mean....	10	26	29	4	6	17	3	5	20	3	7	14	12

The average for this period was 70 % for the region of Gdańsk and 30 % for the western region.

In 1953–54 about 60 % of the flatfish were caught in the coastal regions by motor-boats and row-boats, and about 40 % in areas farther away from the coast by cutters.

Between 1 % and 6 % of the fish were caught by deep-sea vessels using trawls. In 1954 the proportion of this catch taken by trawls in the Gdańsk region was about 40 %, in the Bornholm region it was 70 %, in the Pomeranian region, 43 %. The remainder of the catch was taken by means of nets and hooks.

The monthly landings of flatfish along the whole coast in the period 1946–1956 are given in Table 1. It appears from this table that the largest catch is taken from September to December, with a maximum in November. From April to June the catches are also fairly good.

The catch per effort for the trawl catches taken by cutters of the State fishing enterprises are shown in Table 2.

It should be mentioned that the flatfish caught by cutters were only a by-product of the trawl catches of cod and herring, since the State enterprises were not especially keen on catching flatfish. The amount caught was usually very small, but a steady increase has been observed since 1953.

The proportion of flatfish is highest, as a rule, from November to April during the pre-spawning period of the flounder and plaice, when they migrate from the coast and remain in greater depths. This period coincides with the period when the cod trawl is most used.

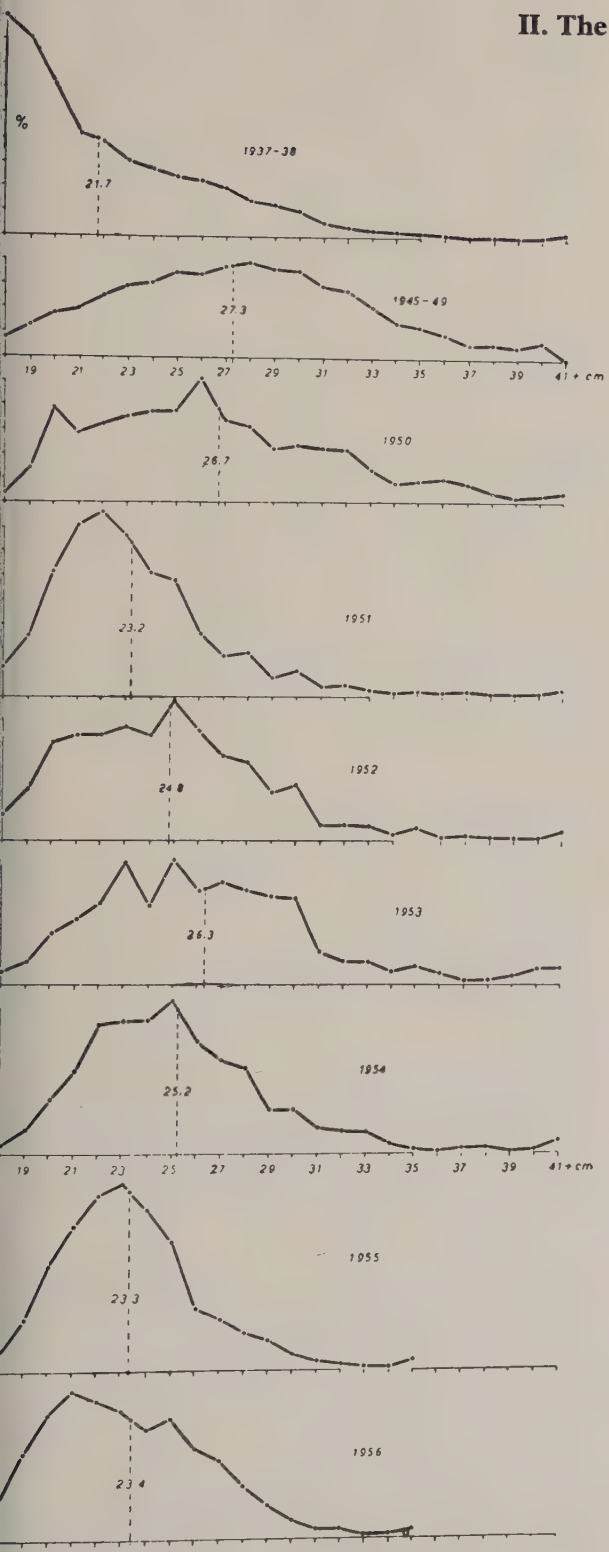

Figure 1. Length of flounder in the Gdańsk area.

II. The Flounder

1. Length and age

In accordance with the 1929 Agreement concluded between Poland, the Free Town of Gdańsk, Germany, Denmark, and Sweden the size limit for flounders was 18 cm in the eastern part (the Gdańsk region), and 20 cm in the central part of the southern Baltic (the Bornholm region). The boundary dividing these two regions was a line drawn from Cape Utlängan in southern Sweden to the mouth of the river Piasnica.

(a) The region of Gdańsk. The length composition of the flounder catches has changed in recent years (see Figure 1).

Immediately before the war, in the years 1937 and 1938 the flounder stock showed distinct signs of being overfished. Small and juvenile fish dominated the catches, and the total catch, as well as the yield, declined considerably when compared with previous years. After the war a marked improvement was noted in the stock of flounder, this being the result of the reduced exploitation of the fishing grounds, which was true for at least part of the war period.

The improvements noted were:

(i) The increase in the average length of the fish caught from 21·7 cm (in 1937—38) to 27·3 cm (in 1945—49).

(ii) The increase in the percentage of older fish in the catches (in 1937 and 1938 juvenile fish from age-groups II and III constituted more than 50 % of the total, while in 1945—49, they made up only 17 %).

(iii) The increase in the yield per cutter during the first post-war years. This yield gradually declined after 1948.

The mean lengths of flounder in the Gdańsk Bay catches during the past 20 years were as follows:—

Years								
1937/38	1945/49	1950	1951	1952	1953	1954	1955	1956
Mean length, cm								
21·7	27·3	26·7	23·2	24·4	26·3	25·2	23·3	23·4

After the marked increase in the number of large fish in the immediate post-war years, a decrease in the average length was found after 1950 with a slight increase again during the period 1952—54.

The age of the Gdańsk Bay flounder (%) in the periods mentioned were as follows:—

Years	Number of fish invest.	Age-groups						
		II	III	IV	V	VI	VII	VIII
1937–38....	8,780	11	32	27	20	6	3	1
1945–47....	3,406	0·3	17	40	28	11	3	1
1953–54....	2,067	2	20	33	25	13	5	2
1955.....	1,161	4	39	33	15	5	2	2
1956.....	1,433	4	37	36	15	5	2	1

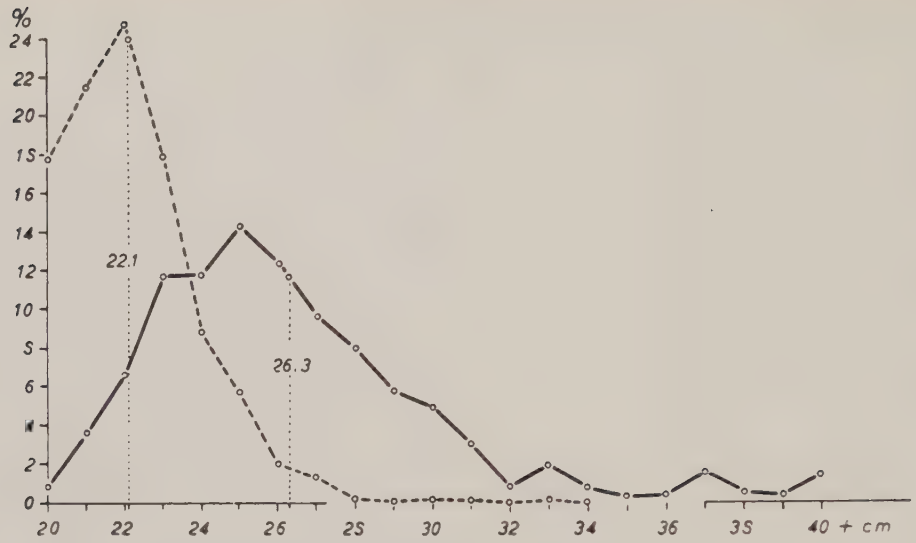

Figure 2. The flounder in the Bornholm area.
●———● On the fishing grounds off Kołobrzeg and Darłowo. ● - - - - ● In Pomeranian Bay.

It will be seen that more older fish were caught in Gdańsk Bay after the war than in the years 1937 and 1938, and it appears also that the fish were larger. In recent years, there have been more young fish in the catches, this phenomenon being accompanied by a decrease in the mean lengths of the fish and an increase in the percentage of smaller flatfish in the commercial landings.

(*b*) *The Bornholm region.* The composition of the trawl catches from the Kołobrzeg-Darłowo fishing grounds and the Słupsk Furrow, as well as from the Pomeranian Bay in 1956 are shown in Figure 2.

The lengths of the flounders from the Pomeranian Bay are very much less than those from the Kołobrzeg-Darłowo fishing grounds, as shown in the figure. This is due to the fact that the Pomeranian Bay is exclusively a feeding ground, whereas the Darłowo-Kołobrzeg area is a spawning ground as well.

The average length of flounder from Pomeranian Bay in 1954 was 22·1 cm, while at the same time it was 26·3 cm on the Kołobrzeg-Darłowo fishing grounds. The difference in the age composition was as follows:—

Age-group	II	III	IV	V	VI	VII	VIII +	Total
Pomeranian Bay.	16	50	26	7	1	–	–	100
Kołobrzeg-Darłowo	2	30	38	18	7	3	2	100

The predominance of the age-groups II and III is very characteristic of the trawl catches in the Pomeranian Bay, and this is still more apparent in the experimental biological catches. It is, however, very unfortunate that only a small part of the flounder (as well as plaice) caught in the trawl is over the size limit, because the majority of the fish caught are thrown back into the sea.

2. Growth-rate

The growth-rate of the flounder varies from year to year. It is greater for the females than for the males. The mean length in cm of the various age-groups in 1953—55 were as follows:—

Region	II	III	IV	V	VI	VII
Gdańsk	19·6	22·8	23·7	26·0	28·6	31·3
Bornholm	21·4	23·0	25·5	28·2	31·8	34·2

The above comparison indicates a higher average annual growth-rate for the western flounder (2·6 cm yearly between the age-groups II and VII) than for the Gdańsk region flounder (2·3 cm yearly).

3. Nutrition factor

The nutrition coefficient, calculated according to Fulton's formula, for the Gdańsk Bay flounder of 20—25 cm in length (in maturity stages II and III) points to rather considerable fluctuations over several years, as follows:—

Year.....	1946	1947	1948	1949	1950
K.....	1·10	1·26	1·23	1·18	1·24

Year....	1951	1952	1953	1954	1955	1956
K.....	1·32	1·27	1·30	1·35	1·29	1·25

. Place and time of spawning

The flounder is a shallow-water fish, which lives ear the coasts and sometimes enters the fresh water s, for example, the estuaries, lakes, and rivers. It eeds relatively salt water for spawning, however, nd for this purpose it migrates to the deeper areas of ne Baltic, and all the more prominent depths of the outhern Baltic, such as the Gdańsk and Gothland Deeps, the Słupsk Furrow, the Bornholm Deep, and ne Arkona Deep, are suitable spawning grounds.

The spawning of the Baltic flounder takes place in pring, the exact period depending on the place and ne year. The duration and the peak of the spawning an be approximately judged by the percentage of running" fish (gonads in stages VI and VII) on the pawning grounds. Spawning in the Deep of Gdańsk n the years 1946—1956 took place between March and une. The percentages of spawning fish were as fol-ows:—

Year	Number of fish	Months				
		II	III	IV	V	VI
946.....	59	–	1	10	–	5
947.....	836	–	–	26	39	0·5
948.....	355	–	26	37	–	–
949.....	247	–	2	28	36	3
950.....	352	–	38	33	–	–
951.....	353	–	25	50	–	–
952.....	174	–	13	28	1	–
953.....	134	–	67	*)	46	–
954.....	186	–	40	68	1	–
955.....	405	–	12	61	51	6
956.....	501	14	19	65	52	–

) No data.

It appears from the above that the spawning max-mum in the Deep of Gdańsk usually takes place in March and April. February and June are of no ac-ount, except in very few years.

Spawning takes place in the same months in the Bornholm Deep. This is apparent from the following able, which gives the percentage of spawning floun-ers present on the spawning grounds in the years 951 to 1956.

Years	Months				
	III	IV	V	VI	VII
951–54....	35	63	21	18	–
956.....	5	18	38	–	–

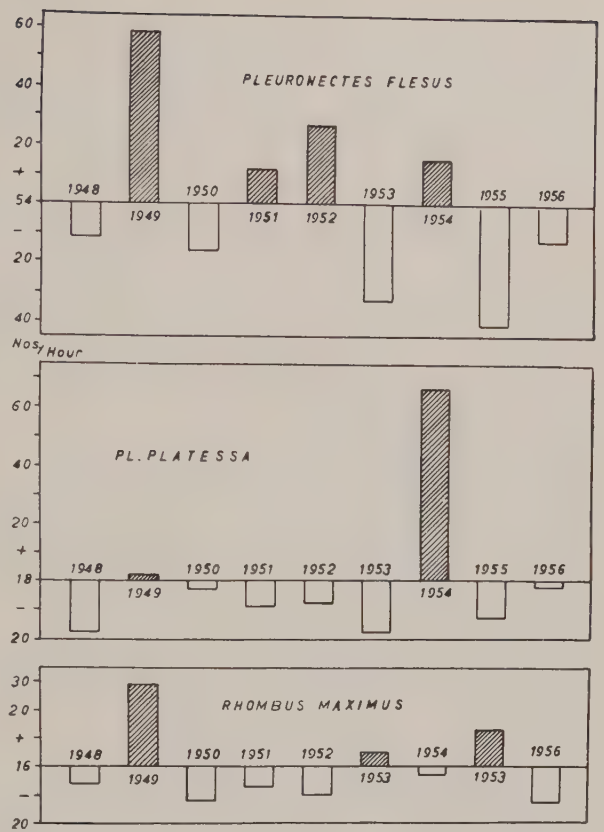

Figure 3. Fluctuations in the number of flatfish fry. Deviations from the average in the period 1948—1956.

Thus the maximum intensity of spawning in the Bornholm Deep occurs in March and April.

5. The relative number of fry

The quantitative surveys of flatfish, carried out since 1948 along the whole coast by means of a push-net, have brought rather variable results, due, no doubt to the annual variation in brood strength (Figure 3). This is one of the factors which has a decisive influence on the number of fish in the future stock and which, to a certain extent, may be assisted by man by protecting the spawning grounds over a certain period.

III. The Plaice

. Length and age

In accordance with the above mentioned Baltic tates Agreement of 1929, plaice of 21 cm in length re caught in the western part of the Baltic and, in ne eastern part, from a length of 18 cm. The compo-tion of trawl-net catches of plaice in these regions differs markedly as regards the length of the fish. This is confirmed by the curves in Figure 4.

In the trawl catches, the plaice from the eastern part of the Baltic are, on the whole, smaller than those from the Kołobrzeg-Darłowo grounds, and still smaller plaice are caught in the Pomeranian Bay, which,

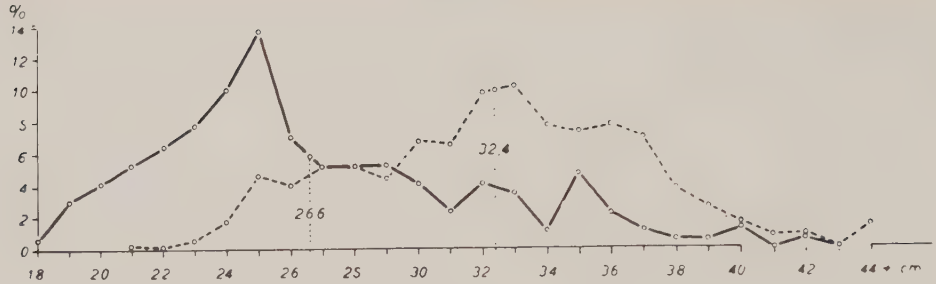

Figure 4. Length of plaice in the trawl catches.
●———● In the Gdańsk area.
●– – – –● In the Bornholm area.

for both plaice and flounder, is exclusively a feeding area.

The mean length of the fish estimated on the basis of samples from the trawl catches in 1956 was 32·4 cm for the Kołobrzeg-Darłowo region, 26·6 cm for the Gdańsk region, and 22·5 cm for the Pomeranian Bay.

The age compositions of the fish originating from the areas mentioned also show considerable differences. These are apparent from the percentage age composition of the trawl-caught fish in 1956 in the Gdańsk region, on the Kołobrzeg-Darłowo fishing grounds, and in the Pomeranian Bay.

Regions	Age-groups						
	II	III	IV	V	VI	VII	VIII+
Gdańsk	–	43	24	12	10	8	3
Kołobrzeg-Darłowo fishing grounds.	–	5	16	16	22	20	21
Pomeranian Bay	7	89	4	–	–	–	–

In the Gdańsk region catches of III-group plaice are the most numerous. This is due to the smaller size limit and to the presence of smaller numbers of older plaice than in the Bornholm Basin.

2. Growth-rate

The rate of growth of the plaice is more rapid than that of the flounder (see Table 3), and the mean yearly increment as calculated from the commercial catches, is 3·1 cm.

In spite of the higher mean length of the plaice caught in the Bornholm region, the annual growth-rate is lower by 0·5 cm than in the Gdańsk region. The cause of this is most likely to be the better feeding conditions in the eastern part of the sea (abundance of *Macoma baltica)*. Besides, the Gdańsk region is exclusively a feeding area for the plaice, and not a spawning ground.

3. Nutrition factor

The more favourable increase in length attained by the plaice feeding in the Gdańsk region is accompanied by a higher nutrition coefficient of the fish in the Gdańsk Bay. The mean values of the nutrition coefficient for fish of 25—30 cm in length were as follows:—

Table 3.

Region	Age-groups						
	II	III	IV	V	VI	VII	VIII
Gdańsk 1954–56	19·6	23·6	25·8	27·8	32·5	35·5	40·0
Bornholm 1951–56.....	20·0	23·7	25·8	28·3	31·0	33·4	37·6

Region	1950	1951	1952	1953	1954	1955	1956	1950–1956
Gdańsk	1·3	1·2	1·2	–	1·1	1·2	1·2	1·2
Bornholm	–	1·1	1·1	1·1	1·2	1·2	1·0	1·1

4. Place and time of spawning

The plaice is a species inhabiting the western parts of the Baltic and while it spawns only there, the limits of its distribution extend far out to the north, beyond Gothland. A productive spawning takes place in the most saline waters of the Baltic, e.g., in the Bornholm and Arkona Deeps, and also, most likely, in the Słupsk Furrow.

The spawning period of the plaice in the Bornholm Deep can be determined by an analysis of the development of the gonads, similar to that which has been carried out on the flounder. The percentages of newly spent and recovering spent fish were as follows:—

Stage of gonads	I	II	III	IV	V	VI	VII	VIII	IX
VI–VII...	3	6	55	32	15	9	–	18	–
VIII	–	3	35	25	47	60	49	73	–

The spawning period of the plaice is longer than that of the flounder and takes place from January to August. The greatest intensity occurs in March and it is only slightly less in April.

5. The relative number of fry

As is obvious from Figure 3, the number of 0-group plaice is more variable than that of the flounder. During the period 1948—1956, 0-group plaice were exceptionally numerous off the Polish coasts in 1954, and in the years 1949, 1950, and 1956 they were also fairly abundant. It should be noted that the 0-group fish appear only on the western coasts, and when they are older they move on to the east across a boundary between Kołobrzeg and Ustka, as one year-old fish.

IV. The Turbot

1. Length and age

The turbot has not yet been protected in the Baltic, but in the North Sea, under the International Convention of 1946, the size limit is 30 cm. Some data similar to those compiled for the flounder and the plaice have been collected for protective purposes.

(a) The Gdańsk region. Turbot of 16 to 55 cm in length appear in the catches and the percentage length composition is shown in Table 4.

Table 4.

Year	Length of fish, cm								Mean length, cm
	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	
1946–52	3·0	24·0	37·8	18·8	10·5	4·0	1·3	0·5	29·8
1955...	8·8	14·0	29·6	19·4	19·3	5·3	1·8	1·8	30·9
1956...	1·8	44·5	24·2	24·1	3·6	1·8	–	–	29·5

The catches of turbot during the last few years show changes in the length composition of the fish, but the mean length of about 30 cm has been the same for a number of years. It will be seen from the percentage age distribution shown in Table 5 that the IV-group predominated.

Table 5.

Period	Age-groups										
	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1946–52....	2	21	26	19	13	10	5	3	0·3	0·3	0·5
1955.....	2	22	47	9	14	2	2	2	–	–	–
1956.....	2	24	52	16	2	4	–	–	–	–	–

(b) The Pomeranian Bay. In the years of 1953—56, turbot was caught in the following length composition:—

16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	Mean length, cm
37	27	15	8	6	5	2	0·3	26·6

Comparing the length composition of fish in the Pomeranian Bay with the Gdańsk region catches, it appears that the turbot, just like the flounder and the plaice, are of smaller size in the Pomeranian Bay.

The stock of turbot there is mainly composed of young fish, the III-group being predominant.

	Age-groups									
	II	III	IV	V	VI	VII	VIII	IX	X	XI
/₀....	33	38	17	2	2	4	3	1	–	0·3

2. Growth-rate

As in the case of the flounder and the plaice the growth was estimated on the basis of the differences between the mean lengths of fish belonging to adjacent age-groups in 1953—56.

Region	Age-groups					
	II	III	IV	V	VI	VII
	Mean length in cm					
Gdańsk	20·2	24·4	27·0	30·2	33·2	35·5
Pomeranian Bay	19·0	23·1	27·4	33·6	38·3	40·0

	Age-groups				
	VIII	IX	X	XI	XII
	Mean length in cm				
Gdańsk	37·4	43·6	44·0	46·0	50·5
Pomeranian Bay	44·1	44·5	–	–	–

The above comparison points to the fact that the growth-rate of the Pomeranian Bay turbot is higher than that of the Gdańsk region. The Pomeranian Bay is thus a feeding ground for the turbot also, especially for the young fish.

3. Nutrition factor

The nutrition coefficient for the turbot of the Gdańsk region, 20—25 cm in length in 1946—56, was rather high: 1·7—1·9. It was higher in the Pomeranian Bay, where in 1956 it amounted to 1·9.

4. Place and time of spawning

The turbot is a warm-water species and spawning takes place during the summer months in the warmest coastal waters, and it is unlikely that it undertakes spawning migrations to more distant grounds. Running and half-spent males and females are found only in June and July and spent fish from June to September.

5. Relative number of fry

Fish belonging to the 0-group appear along the entire Polish coast, just like 0-group flounder. They are most numerous when the sea is calm, and are found close to the coast up to a depth of ½ m. From Figure 3 it may be observed that the recruitment pattern of the turbot is more uniform than that of the other flatfish.

V. Conclusions Regarding the Protection of Flounder, Plaice, and Turbot

The methods used for the protection of flounder and plaice appear so far to have been insufficient, for, in spite of having been applied since 1929, they have not been able to check the decimation of the stock. This decimation was first observed in the Bornholm region before 1935, as mentioned by Meyer (1939, 1941), and somewhat later, in 1937 in the eastern Baltic, as seen from Polish investigations (Cieglewicz, Mulicki, 1937). The period of rest during the second World War contributed radically to the improvement of the stock of flounder.

Too many young, immature flatfish are, however, caught by Poland and, since flatfish are long-lived, they ought to be fished out at an older age. This is important as the propagation of these species is not so abundant as with other Baltic species.

The stock of these species is liable to be overfished unless proper protective measures are introduced, especially during the spawning time. In this period the turbot assemble, for a fairly short time in small areas on the sea bottom; the young fish are then exposed to capture by the fine-mesh seines and trawls used, for example, for catching eels.

Owing to their vitality and ability to live a fairly long time out of water, the flatfish can very easily be protected. Scientific research suggests that the protection of flatfish should be by means of a size limit of the fish based on the sexual maturity and the spawning time, and the catching of juvenile fish which have not yet spawned should be avoided. This chiefly concerns the females which are less numerous in the stock than the males and which mature at an older age. The present regulations protect small females whose length is much smaller than the average length at first maturity.

Table 6 shows the number per mille of the spawning females of flounder and plaice at each cm length in the catches from the Gdańsk and Bornholm Deeps grounds.

The lengths at first spawning are 2 cm higher for the flounder than the minimum size limit of the 1929 Convention in the Gdańsk region and 1 cm higher in the Bornholm region. For the plaice, it is 1 cm higher in the Bornholm region.

Owing, however, to the scarcity of flounder and plaice of these sizes on the spawning grounds (see Table 6) the size limits should be raised somewhat—by at least 1—2 cm. It would be reasonable to accept the following lengths:—

Gdańsk region flounder ..... 21 cm
Bornholm region flounder ..... 23 -
Plaice from both regions ..... 23 -

Table 6. Spawning and spent flatfish females (maturities VI and VII) (‰) on the fishing grounds, according to length (cm)

Length, cm	Flounder		Plaice
	Gdańsk Deep 1946–1956	Bornholm Deep 1953–1956	Bornholm Deep 1953–1956
18	–	–	–
19	–	–	–
20	4	–	–
21	9	27	–
22	8	9	6
23	23	27	–
24	41	18	13
25	48	63	20
26	43	100	–
27	75	72	32
28	76	81	6
29	67	90	26
30	81	81	58
31	63	54	65
32	83	45	84
33	75	72	91
34	64	54	116
35	80	36	70
36	40	36	58
37	39	18	58
38	33	45	71
39	17	18	39
40	14	18	45
41	12	27	19
42	4	9	45
43	1	–	78
Total	1000	1000	1000
Number of specimens	749	111	155
Length at first spawning	20	21	22

The same size limit, which is suggested for the Bornholm plaice, should also be accepted for the Gdańsk region plaice as this species originates from the western spawning grounds.

It is suggested that 23 cm should be the size limit for the turbot in both regions. The fact that female turbot of 24 cm in length and upwards spawn in the Gdańsk Bay supports this proposal. Males of a smaller size participate in the spawning, and there is a considerable percentage of maturing individuals in their third year of life (age-group II) both among the males and the females. One size limit for both regions —the same as that proposed for the plaice—would be very convenient, as this would simplify the control on the part of the administrative authorities.

Apart from introducing the minimum length of plaice the prohibition of the landing of female plaice during the spawning period should be maintained. This prohibition should also apply to the flounder and the turbot, and the fishermen should be advised

throw all the full females of the three species back to the sea.

With regard to the spawning period of the flatfish, is suggested that the months of March and April hould be accepted as the close season for spawning emale flounder and plaice, and June and July for emale turbot.

The geographical boundary should be a natural one as proposed at the beginning of this paper, running along the meridian across the eastern sill of the Słupsk Furrow.

With regard to a size limit for the fish in the westernmost Baltic no proposals are put forward from Poland as no observations have been made.

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4.

The State of the Stock of Cod in the Southern Baltic as Indicated by Polish Investigations

By

St. Rutkowicz

The term "southern Baltic" is applied to the area stretching from the Arkona Deep in the west (including the Deep itself) through the Bornholm Basin, the Gdańsk Deep, and the middle part of the Gothland Deep. The northern border is conventionally put at latitude 57° N. All the fishing grounds exploited by the Polish Baltic fishermen are found in this area.

After the second World War, the Polish fishery in the Baltic developed rapidly, the cod forming up to 80 % of the total Polish catches from the Baltic.

The great economical importance of the cod necessitated constant biological investigations into the dynamics of the stock and its resources, and the Polish Sea Fishery Institute in Gdynia has conducted such investigations since 1946. Investigations dealing with the western Polish coast, including the landings in the Darłowo and Ustka have been carried out by branches of the Institute at Swinoujscie and Kołobrzeg, while other investigations regarding the east coast, including the catches landed at Władysławowo and Hel, were made by the Institute in Gdynia. It should be stressed that the cod fishery on the eastern fishing grounds (the region of Gdańsk) as a rule provides 70 to 80 % of the total annual Polish catch of cod.

Cod catches from 1946 to 1956

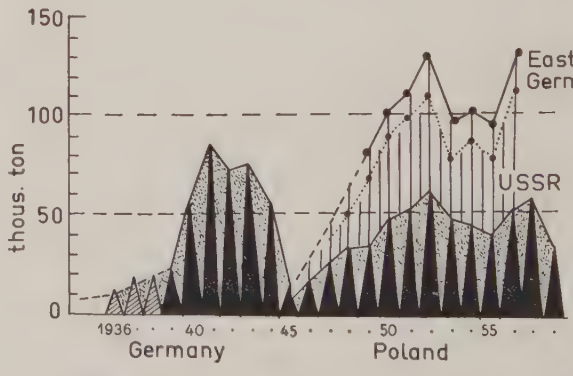
In the first post-war years the catch increased to a large extent, on account of the development of the Polish fishing fleet in the Baltic. The state of the cod stock, especially on the eastern fishing grounds, was highly satisfactory, and the results per unit of effort (per hour's trawling) were very good.

There are reasons for believing that the decline in the exploitation of the cod in the Baltic during the last two years of the war (after the intensive exploitation by the German trawlers in the years from 1939 to 1941), together with the relatively weak exploitation up to 1948 or 1949 was the cause of the large catches. The later increase in the catches was due to the development in recent years of the fishing fleets of Poland and other Baltic states, but this eventually caused a reduction in the cod stock, especially on the Gdańsk grounds. The best catches of cod, attained so far were in 1952, but after that year a slow but constant decline in the catches of cod on the Gdańsk fishing grounds was noted (see the table below). An increase was observed in 1956 in both the yield per unit of effort and in the total annual catches.

Annual yield (kg) of cod per hour's fishing on Gdańsk fishing grounds

1950	1951	1952	1953	1954	1955	1956
150	126	118	96	93	91	103

Similar tendencies to those mentioned above have been mentioned in other papers on the yield of cod



Total yield of all countries before 1939.
Maturity stages III, IV, V, and partly II.
Juvenile and spent fish in maturity stages I, VI, VII, and VIII.

Figure 1. Catches of cod taken by trawl in the southern Baltic during the period 1935—1956.

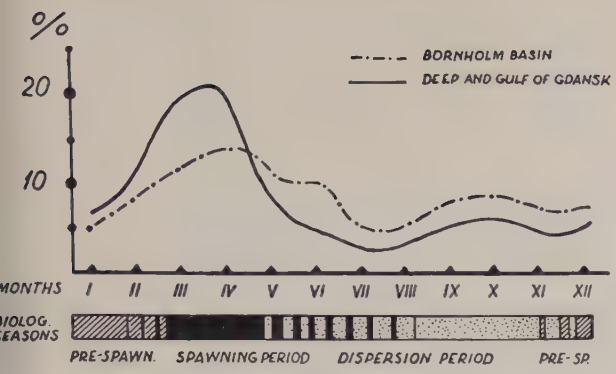


Figure 2. The percentage distribution of Polish cod catches taken in the southern Baltic in the different seasons of the year 1953.

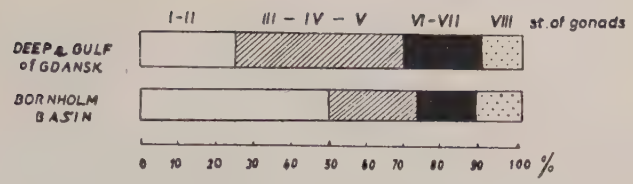


Figure 4. Polish catches of cod in the southern Baltic in 1955–56, according to stages of maturity.

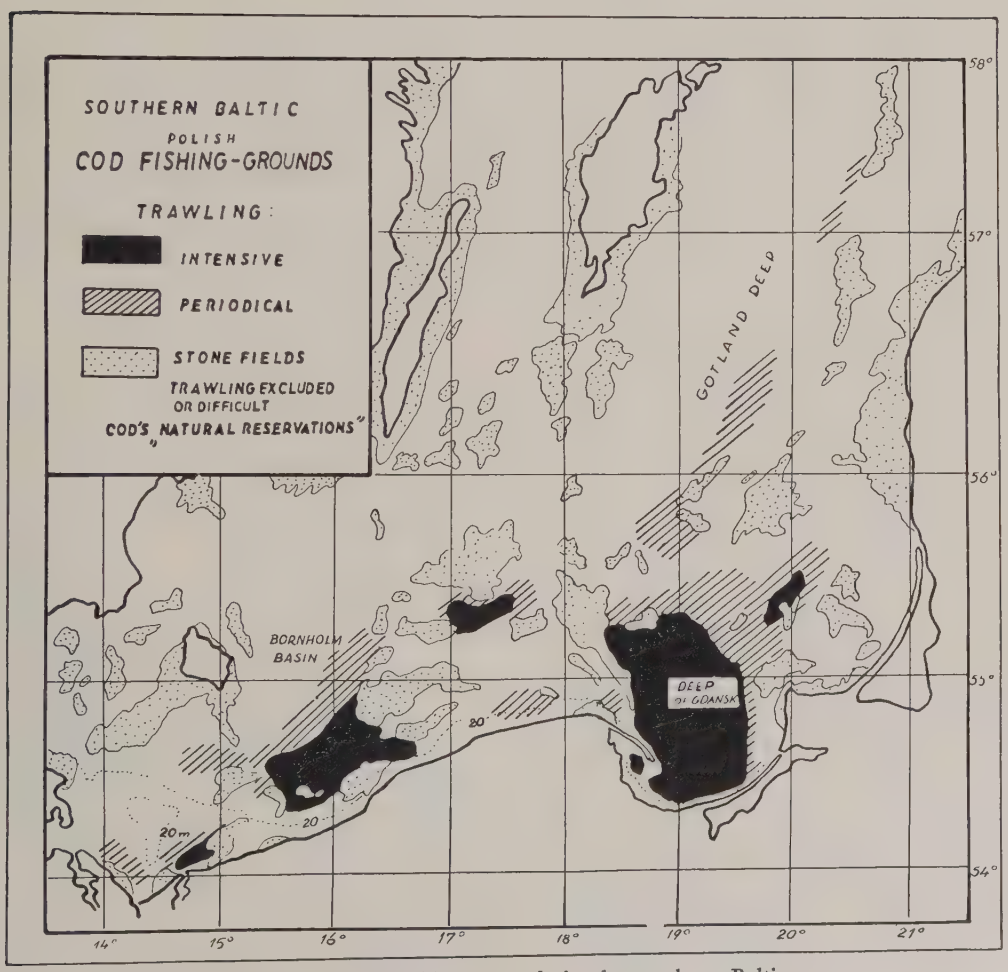


Figure 3. Polish fishing grounds in the southern Baltic.

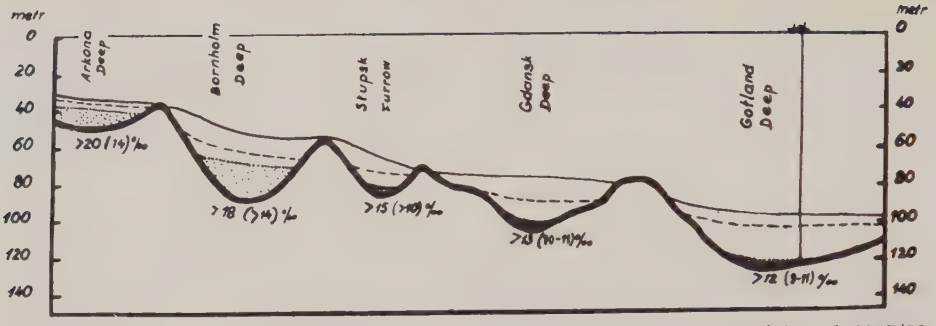


Figure 5. The near-bottom salinity conditions in the southern Baltic in 1951/52 and 1957/58.
———— 11 ‰ isohaline in 1951/52.
– – – – – – – 11 ‰ isohaline (mean) in 1953/57.
. . . . . 11 ‰ isohaline in the spring of 1958.

estimated per 3 cutter/day for the whole Polish cutter fleet during this period (Janko and Łaszczynski). It is worth noting that a similar gradual decline in yield was observed by the Germans on the Gdańsk-Gothland fishing grounds in the years from 1942 onwards after a period of intensive trawler exploitation which started in 1939 and reached a peak in 1941 (Figure 1). Figure 1 also shows the catches of the Polish cod fishery from 1946 to 1956, both years inclusive. The average annual catch of the Polish cod fishery in the Baltic from 1950 to 1956 amounted to 40,000 to 60,000 tons.

Fishing grounds and yearly cycle of exploitation

On the whole the cod fishing areas in the Baltic have not changed in any material way. During the spawning period the cod concentrate in the main bottom depths, i.e., in the Arkona and Bornholm Deeps, the Słupsk Furrow, and the Gdańsk and Gothland Deeps, where they find the best ecological conditions for reproduction. There, the best fishing results are obtained (see Figure 3). During the last decade the largest catches, both as regards number of individuals and weight have been taken in the maturing stages (III, IV, V), i.e. in the pre-spawning concentrations (Figure 2). This is especially true in the case of the cod from the Gdańsk fishing grounds, but cod in this stage of maturity are much less numerous in the catches from the Bornholm Basin fishing grounds (see Figure 4). The catches of cod in the Bornholm region reach their peak in spring, i.e., in the spawning period (Figures 2 and 4). Of the catch of cod in the Gdańsk Basin, 70 % falls in the first half of the year as a rule, while the summer and autumn months have given low catches, especially during the past few years.

The spawning areas and the specificity of the Baltic

The productivity of the Baltic cod depends, to a large extent, upon the spawning having taken place in sufficiently deep areas, where the average salinity is about 12 ‰. The chances of a favourable spawning are increased by the periodical inflows of near-bottom water from the Sound and the Belts. These inflows increase the extent and thickness of the bottom layer with a high salinity, but they only take place irregularly e. g., in 1947 to 1949, and 1952 (cf. Figs. 5 and 7).

It may be assumed that under these conditions the spawning cod does not only concentrate at such depths but that it also finds favourable conditions on the broader areas of the slopes (Figure 6).

Large areas of the bottom of the Baltic are either stony or rocky and on them it is almost impossible to trawl (Figure 3). These places are, no doubt, natural reservations for the cod.

The periodical vertical changes in the distribution

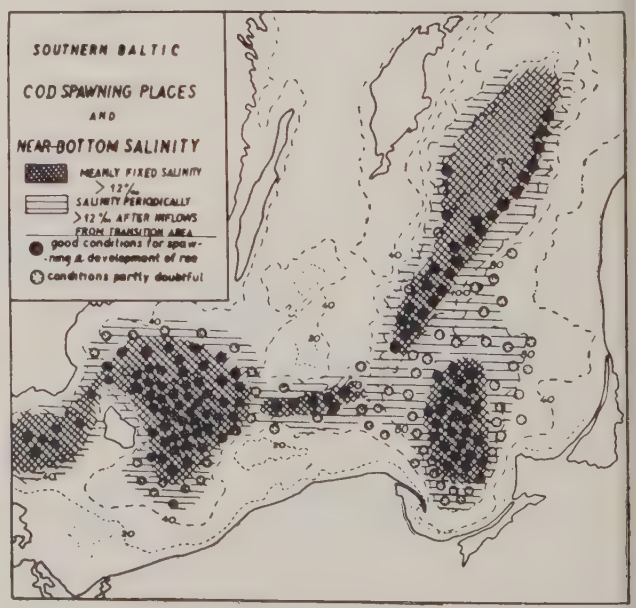

SOUTHERN BALTIC
COD SPAWNING PLACES
AND
NEAR-BOTTOM SALINITY
NEARLY FIXED SALINITY > 12‰
SALINITY PERIODICALLY > 12 ‰ AFTER INFLOWS FROM TRANSITION AREA
good conditions for spawning & development of roe
conditions partly doubtful

Figure 6.

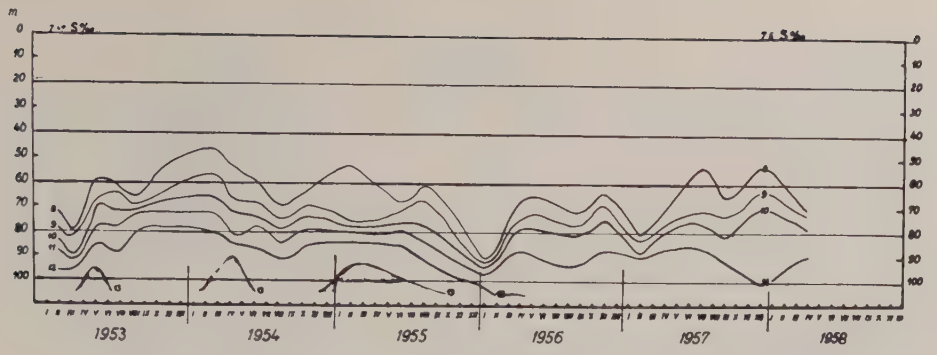


Figure 7. Salinity in the Deep of Gdańsk in the period 1953–1958.

of the cod (which have been observed during the investigations with echo-sounders) exclude the possibility of always finding cod within the reach of the normal bottom trawl. This fact no doubt offsets, to a large extent, the destructive activity of the trawling industry. Nevertheless, the Baltic cod stocks are in a critical state.

The isolation of the Baltic and the lack of direct communication with oceanic areas prevent the greater exchange of water and of food organisms. Investigations carried out to date have confirmed that there is no distinct direction in the migration of cod and that the extent of the mass migration of the fish is not great. Food conditions and the conditions for reproduction of the cod are generally rather poor, because of the great differences in the local hydrological and biocenotic conditions. All these exert a considerable influence on exploitation, varying in the different regions of the area, which in itself is rather small. Even considering the great biotic power of the Baltic cod, we must assume that intensive exploitation will very much reduce the size of the particular stock at given periods of time on particular fishing grounds. The heavy catches of cod in the period just before spawning have been mentioned earlier, as well as the occasional excessive catches of juvenile fish, which will be dealt with later.

The age composition of the stock of cod

The Polish Sea Fisheries Institute is conducting, both in the ports and on board fishing vessels, a detailed analysis of the catches in the eastern and the western regions. The ages of about 6,000—7,000 cod from the Baltic are determined each year (the number of unreadable otoliths varies between 5 % and 10 %).

Eleven years of investigations show that fish belonging to the 3 and 4 year-old groups constitute, as a rule, 60 % to 75 % by weight of the annual landings of the cod from the southern Baltic. Not until the past two years did these age-groups decrease to below 60 % accompanied by an increase in the proportion of the younger year-classes. This war particularly clear in the Gdańsk area. A detailed review of the changes in the percentage by weight of the particular age-groups in the Polish catches of cod on the Gdańsk fishing grounds is given in Figures 8 and 8 a.

This is a new method of presenting diagrammatically the size of particular broods, i.e., a modification of the commonly used method of presenting these data by means of columns (Figure 8). In Figure 8 a the size of a given brood is represented planimetrically, and it is obvious that the 1943 to 1945 year-classes were numerous, due, it is believed, to the decrease in the intensive exploitation during the latter years of the war. The 1946 year-class and those immediately following could be regarded as average, whereas the 1949 year-class was outstandingly numerous. The 1950 and 1951 year-classes seem to have been very poor although these years gave maximum catches of cod on the Gdańsk fishing grounds. The 1953 and 1954 year-classes may be regarded as being very good. This was the foundation of a prediction of the results, and the increase of yields in the years 1956 and 1957 and eventually in 1958. Rather unfavourable ecological conditions (hydrothermic, salinity, an unusually severe winter, stagnation, no inflows) were observed during the spawning period for cod in 1956 and 1957. These factors may have an unfavourable influence on the number of recruits from 1959 to 1961 and might be the cause of a decreased yield during this period.

The cod of the southern Baltic is a fish of great economic importance, as shown by its high proportion in the total catch, but not until it is three years old. Summation of the percentage occurrence of a given year-class in the catches of the first three consecutive years (in Figure 8 a along the oblique line) provides a numeral indicator denoting the strength of a given year-class. This indicator for cod is given as "S_3", which is a numerical measure of the strength of a year-class. It amounts to 44·4 for the 1947 year-class, 51·6 for the very good 1949 year-class, and 33·9 for

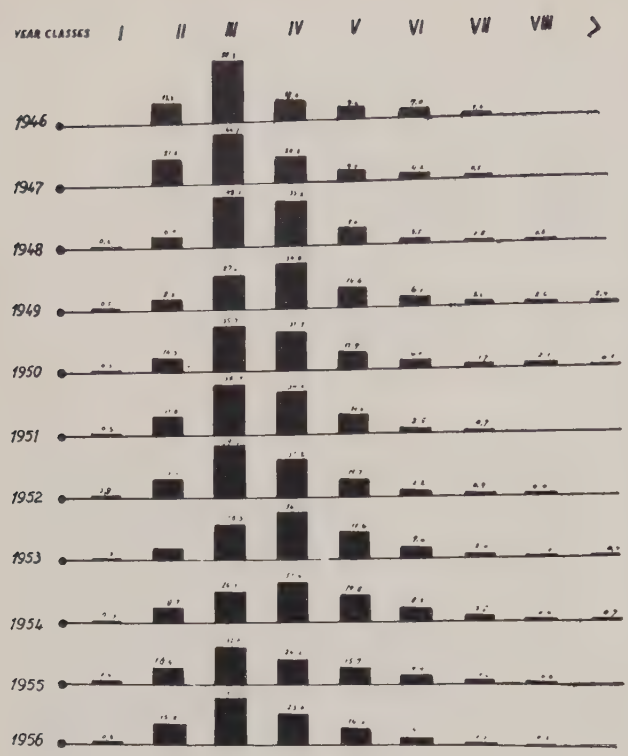


Figure 8.

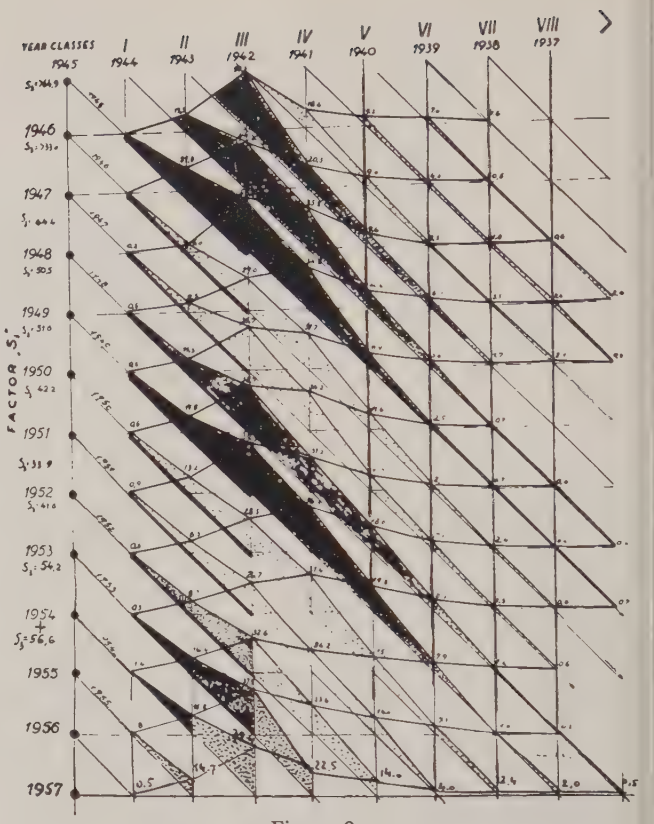


Figure 8 a.

the very poor 1951 year-class. This method is regarded as an auxiliary in forecasting the fisheries.

Maturity, length, and rate of growth

Investigations have shown that for several years the mean data have not been subject to any great changes. Males mature more quickly than females. In the age-group II of males, 20 to 30 % are ready to spawn, and it may be assumed that almost all the males in group III (after three years of life) take part in the spawning. Baltic cod in the spring attain the following lengths (cm):—

	Age-group		
	I	II	III
Males	18–25	25–36	34–43
Females	18–27	24–38	34–45

The range in length of an age-group is large owing to the long spawning period (March to August). Females mature later than the males, and a very small percentage of females are ready to spawn after two years of life but the majority spawn after the third year. The rate of growth is slightly higher than that of the males (Figure 9).

In general it may be stated that none of the cod spawn before reaching a length of 25 to 30 cm, and up to 20 % of the cod about 35 cm long spawn for the first time. A considerable proportion of cod of 40 cm in length or more spawn. The rate of growth of the cod varies greatly depending on the region in which the fish lived for a long period. This is due to the very marked differences in the abundance of food. It seems, however, that the rate of growth does not greatly diminish until after the fifth year of life.

The mean lengths and weights of cod from the Gdańsk region in 1955 were as follows:—

	Age-group					
	I	II	III	IV	V	VI
Average length (cm)	25	34·1	41·1	47·2	57	65·5
Average weight (g)	100	375	715	1,065	1,625	2,660

Length composition of the catches

The annual mean length was 40 cm in 1955, both on the Gdańsk and on the Bornholm fishing grounds. The catches of small cod belonging to the 0- and I-groups increased considerably during recent years, and this has been confirmed by the fishermen. As shown by measurements of landed cod, the percentage of juvenile cod less than 30 cm in length, has increased.

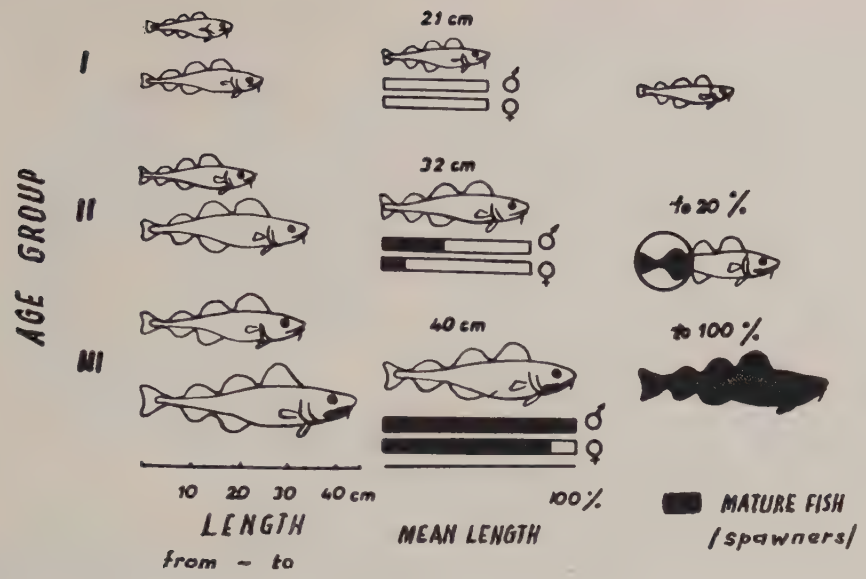


Figure 9. Polish cod catches in the southern Baltic. The ratios of age, length, and maturity.

In the past five years juvenile cod up to 30 cm in length represented 2 to 4 % of the total annual catch, and 5 % of the weight of the landings in 1955. This confirms the necessity for introducing protective measures to prevent excessive catches of these young fish.

The average annual composition of cod as regards length (on the basis of weights) in the eastern region is shown in Figure 10. The data are for the years 1955 and 1956 and are typical for the whole period of the past five years. From 1948 to 1951, however, there were more older fish, the average length of which was greater. It is apparent therefore that the percentage of juvenile fish in the catches has increased.

The length composition of the catches in the eastern Gdańsk area is similar to that of the western regions (Bornholm). In both regions 85 % of the cod range in size from 31 to 60 cm. Numerically, cod from 36 to 50 cm in length are most abundant in the catches, comprising 60 % of the fish caught. As mentioned above, they belong to the III- and IV-groups.

There have, however, been greater increases in the catch of juvenile cod of the 0 and I (and partly II) age-groups in the Bornholm region as compared with the eastern fishing grounds, and especially in the Deep of Gdańsk.

The migration of the cod

In the years from 1948 to 1953 the migration of the cod was investigated by tagging. About 3,200 individuals were tagged during this period in various seasons of the year and in different regions from the Arkona Deep to beyond the Gothland Deep. The tags returned numbered 112, i.e., 3·7 %. Conclusions drawn from these observations are as follows.

The older fish migrate even longer distances than the younger individuals. Migrations have been recorded up to 200 sea miles, the distances depending on the biological state of the fish (the migration to the spawning and feeding grounds). The maximum speed of the migration has been 4 sea miles per day (24 hours).

The direction of the migration varies, but, in most cases, however, it is westwards or eastwards. This points to the fact that the fish migrate to an environment of a different hydrochemichal character (Fig. 11).

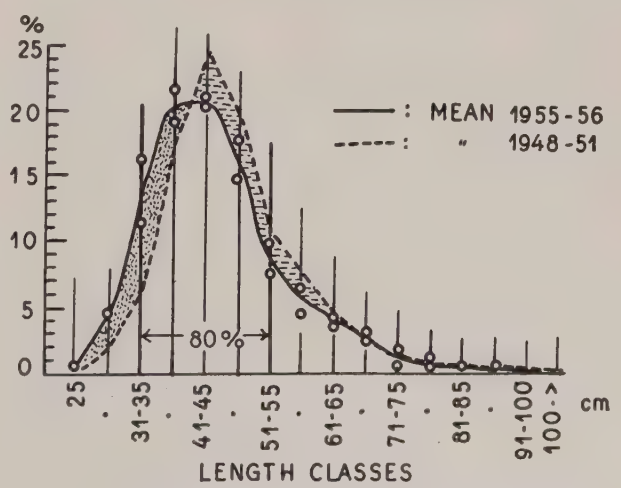


Figure 10. Length composition of cod in the Gdańsk region.

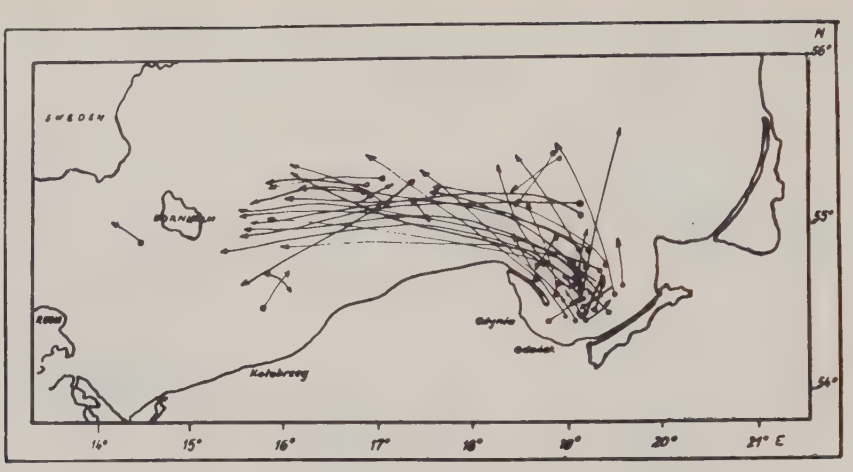


Figure 11. Polish tagging experiments during 1957/58.

Seasonal reproductive and feeding migrations have been noted, but no tags have been received from areas outside the Baltic. It is obvious therefore that the stock does not migrate beyond the area of the Baltic, and the interchange of fish between the basins is not extensive under normal conditions. The percentage of various fish recaptured in the different regions, was as follows: Bornholm Basin: 5·6; Gdańsk: 4·7 %; Gothland: 0·5 %; Słupsk Furrow: 1·5 %. The above distribution may, to a certain extent, be considered as indicators of the intensity of exploitation of the particular area of the fishing grounds.

In 1956 and 1957 a new series of tagging experiments was started. About 1,300 individuals were tagged during five months, as follows:—

Bornholm Basin.....	300	tagged,	5·3 %	recaptured
Słupsk Furrow.....	400	„	2·5 %	„
Deep of Gdańsk	600	„	4·4 %	„

These results seem to confirm former observations.

In the spring of 1956, which followed an unusually cold winter, a number of cod tagged by Swedish scientists in the region of the Åland Islands and by USSR scientists in the Windawa and Klajpeda regions, were caught by Polish fishermen.

Mortality of the cod in the southern Baltic

Studies on natural mortality and fishing mortality have been started recently. At the moment it is not possible to deal with these problems in the usually accepted manner. It is worth mentioning, however, that some definite lines are emerging from these investigations, and the following discussion will be limited to simple observations.

Using the simple method (as used by Hodgson) to estimate the annual total mortality rate (i.e., percentage changes in the proportions of the age-groups from III to VIII) we obtain the following data for cod of the Gdańsk region:—

	Percentages of age-groups							
	II	III	IV	V	VI	VII	VIII	
1948–51	180	420	300	60	18	1	1	
Total mortality in %.....		–	30	80	70	94	–	mean 68
1955–56 period	280	400	210	60	20	3	1	
Total mortality in %.....		–	*48*	71	66	85	–	mean 67

In the last period the mortality of cod belonging to age-groups III and IV has increased rather considerably, from 30 % to 48 %. However, the mean value for the III-VIII groups for both periods was, in fact, unchanged. The effect of the productivity of the various broods becomes evident when it is considered that the total mortality in all groups does not change. The increasing mortality (fishing mortality) in the younger age-groups is a sign that there is an urgent need to protect the juvenile fish, as already mentioned.

The proposed protective measures

The first measures for the protection of Baltic cod which should be introduced is a minimum size of this fish. It is suggested that a length of 30 cm, which was obligatory under the Convention of 1946, should be adopted. This length is not fully justified, but it approaches the biological size limit.

By protecting young fish up to 30 cm the increased chances of obtaining, a year later, fully mature fish are obvious. These fish would participate in the spawning and would produce a new generation, and the

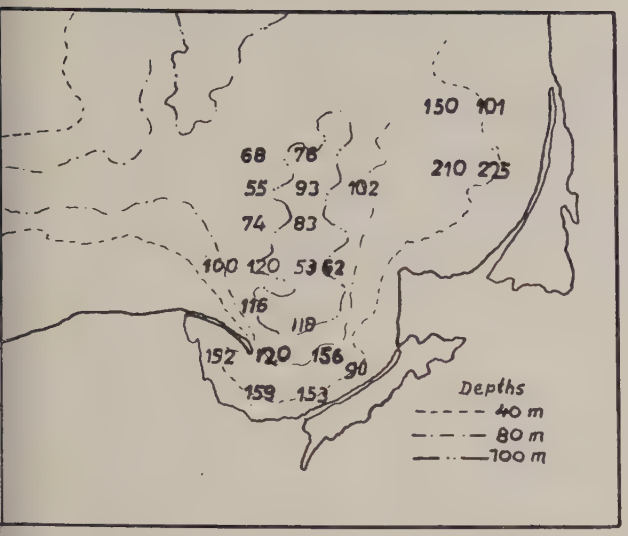


Figure 12. By-catch of undersized cod from the SE Baltic fishing grounds (in 1000) taken in 1956 (Jan. to June) by cod trawl with 80 mm mesh in the cod-end.

ength and weight increase obtained as a result of an effective protection would contribute further advantages.

As a consequence of introducing a minimum size of ish, the fishing gear, in this case the trawl, must be adapted to comply with the requirements as regards he protection of fish. The undersized fish must be given a chance to escape from the trawl cod-end, and our investigations and experiments conducted elsewhere, indicate that the size of mesh of 80 mm (in he wet state, cotton twine) provides the necessary election.

It is true that large numbers of young cod are caught together with the herring in trawls with cod-end meshes of a smaller size. It should be stressed that these trawls are not commonly used until the second half of the year, i.e. in the herring season, when the cod, both mature and juvenile, are feeding intensively in the depths, and do not concentrate in shoals near the bottom. Attention should therefore be focused on enforcing restrictions with respect to the size of meshes and other protective measures during the period of large catches of cod during the first and second quarters of the year. This is the period, when, on an average, 80 % of the total annual yield of cod is obtained.

The catches of undersized cod in some areas of the fishing grounds, where the young individuals of this species are abundant, are a separate problem. Some observations have been started (see Figure 12)and the investigations are being continued. Very likely it will be possible in the future to close certain areas or introduce temporary limitations should they be deemed necessary.

It seems reasonable to allow a certain percentage of admissible "by-catch" of undersized cod, say, 5 % by weight of the fish caught. Such an arrangement should, however, be regarded as a temporary one.

All vessels using trawls should change fishing grounds when the "by-catch" exceeds the authorized percentage.

All protective measures should be subject to regular observations and investigations, in order to establish their usefulness and adaptability. Consultations, exchanges of information, and discussions at regular intervals seem to be indispensable, as these would render possible the introduction of changes in the regulations aimed at protecting the fish.

5.

Some Comments on Statistics Relating to Swedish Fisheries in the Baltic

By

Sven Sahlin

No statistics exist showing the total number of Swedish fishermen, boats, and vessels participating in the fishery for cod, plaice, flounder, dab, and turbot in the Baltic. Special figures giving more detailed information are, however, recorded concerning the Swedish fisheries by trawl and Danish seine in the Baltic (cf. Table 1 and Figure 1). The statistics produced below are extracts from the official fishery statistics for Sweden. The quantities are given in metric tons. Figures 2 to 5 show the total Swedish catches of cod, plaice, flounder, dab (the last two species are taken together), and turbot in the Baltic, for the south and east coasts of Sweden. The boundary between the two latter districts is at the Cape of Torhamn in the south-eastern part of the county of Blekinge. The term "south coast" means the coast between Falsterbo and the Cape of Torhamn. Figures of the total catch of brill are not available. Only small quantities of brill are, however, caught. In the official

Figure 1. Number of vessels in the trawl fishery and the Danish seine fishery of Skåne and Blekinge.

Figure 2. Cod. Total Swedish catch in the Baltic.

Table 1. Swedish trawl fisheries in the Baltic, 1932 to 1955

The figures show the number of fishermen, vessels, and gears in the different counties on the Baltic coast of Sweden and the catches taken by the fishermen from these counties by trawl and Danish seine in the Baltic. As the counties of Malmöhus and Kristianstad also have coasts at the Sound and the Kattegat, the table includes in the period 1945 to 1955 numbers and catches from the last mentioned coasts. These numbers and catches are as yet small. Catches made in the Baltic by fishermen from the counties of Halland and Bohus (on the west coast of Sweden) are not included. The trawls in the column "Trawls not specified" are evidently for the most part trawls used for catch of cod and flatfish.

B = County of Blekinge
G = County of Gothland
KN = County of Kalmar (northern part)
M = County of Malmöhus
KS = County of Kalmar (southern part)
N = County of Norrbotten
S = County of Stockholm
K = County of Kristianstad

Year	District	Number of fishermen	Number of gears				Number of vessels	Catch (metric tons)							
			Trawls not specified	Herring trawls	Trawls other than herring trawl	Danish seines		Herring	Cod	Plaice	Dab	Flounder	Dabs + Flounder	Other fishes	Total
1932....	B	49	80	–	–	–	20	–	43	205	391	228	–	–	867
	K	38	64	–	–	–	19	–	31	138	212	114	–	9	504
	M	18	13	–	–	–	8	–	1	37	97	7	–	4	146
	Total	105	157	–	–	–	47	–	75	380	700	349	–	13	1,517
1933....	B	49	75	–	–	–	20	–	81	155	300	148	–	–	684
	K	40	58	–	–	–	20	–	111	139	157	122	–	8	537
	M	17	29	–	–	–	8	–	2	21	59	6	–	1	89
	Total	106	162	–	–	–	48	–	194	315	516	276	–	9	1,310
1934....	B	48	74	–	–	2	20	–	321	184	253	163	–	–	921
	K	42	64	–	–	–	21	–	168	186	180	57	–	1	592
	M	20	18	–	–	–	8	–	4	26	53	7	–	3	93
	Total	110	156	–	–	2	49	–	493	396	486	227	–	4	1,606
1935....	B	52	76	–	–	3	22	–	942	171	206	183	–	–	1,502
	K	46	68	–	–	–	23	–	439	106	132	58	–	6	741
	M	14	16	–	–	–	7	–	4	12	23	9	–	1	49
	Total	112	160	–	–	3	52	–	1,385	289	361	250	–	7	2,292
1936....	B	72	95	–	–	3	29	–	1,146	83	182	155	–	–	1,566
	K	48	71	–	–	–	24	–	770	105	244	67	–	9	1,195
	M	12	16	–	–	–	7	–	6	21	48	13	–	8	96
	Total	132	182	–	–	3	60	–	1,922	209	474	235	–	17	2,857
1937....	B	79	103	–	–	3	32	–	1,443	105	304	163	–	–	2,015
	K	46	68	–	–	–	23	–	490	67	169	15	–	1	742
	M	14	18	–	–	–	7	–	17	38	41	12	–	11	119
	Total	139	189	–	–	3	62	–	1,950	210	514	190	–	12	2,876
1938....	B	79	103	–	–	3	32	–	1,139	42	–	–	365	–	1,546
	K	48	72	–	–	–	24	–	580	69	–	–	188	3	840
	M	18	22	–	–	–	10	–	12	28	–	–	37	7	84
	Total	145	197	–	–	3	66	–	1,731	139	–	–	590	10	2,470
1939....	B	70	87	–	–	–	28	–	1,050	35	–	–	240	–	1,325
	K	53	76	–	–	–	26	–	754	96	–	–	120	2	972
	M	18	25	–	–	–	11	–	91	19	–	–	27	4	141
	Total	141	188	–	–	–	65	–	1,895	150	–	–	387	6	2,438
1940....	B	21	34	–	–	–	10	–	52	2	–	–	4	–	58
	K	53	76	–	–	–	26	–	546	31	–	–	75	1	653
	M	14	21	–	–	–	8	–	13	2	–	–	9	1	25
	Total	88	131	–	–	–	44	–	611	35	–	–	88	2	736

(continued on next page)

Table 1 (continued)

Year	District	Number of fishermen	Number of gears: Trawls not specified	Herring trawls	Trawls other than herring trawl	Danish seines	Number of vessels	Catch (metric tons): Herring	Cod	Plaice	Dab	Flounder	Dabs + Flounder	Other fishes	Total
1941....	B	64	83	–	–	–	26	–	256	2	–	–	14	–	272
	K	61	85	–	–	–	29	–	892	55	–	–	210	2	1,159
	M	22	32	–	–	–	12	–	154	23	–	–	57	6	240
	Total	147	200	–	–	–	67	–	1,302	80	–	–	281	8	1,671
1942....	B	53	81	–	–	–	21	–	744	4	–	–	20	27	795
	K	70	103	–	–	–	33	–	1,646	33	–	–	83	5	1,767
	M	29	36	–	–	–	14	–	127	15	–	–	68	18	228
	Total	152	220	–	–	–	68	–	2,517	52	–	–	171	50	2,790
1943....	B	55	–	19	63	–	22	54	1,150	2	–	–	37	1	1,244
	K	107	–	9	143	–	49	331	1,934	23	–	–	132	22	2,442
	M	37	–	18	60	–	23	50	307	12	–	–	46	23	438
	Total	199	–	46	266	–	94	435	3,391	37	–	–	215	46	4,124
1944....	B	57	–	21	64	–	23	314	1,292	1	–	–	61	–	1,668
	K	110	–	41	115	–	51	559	1,342	11	–	–	110	12	2,034
	M	37	–	11	56	–	15	33	342	14	–	–	22	4	415
	Total	204	–	73	235	–	89	906	2,976	26	–	–	193	16	4,117
1945....	G	16	–	–	–	8	8	–	–	–	–	–	37	–	37
	B	57	–	21	63	–	23	539	1,505	1	–	–	92	–	2,137
	K	118	–	53	103	4	50	496	2,017	26	–	–	146	7	2,692
	M	33	–	9	34	3	15	30	359	18	–	–	35	6	448
	Total	224	–	83	200	15	96	1,065	3,881	45	–	–	310	13	5,314
1946....	KS	4	–	–	–	2	2	–	–	–	–	–	1	–	1
	G	18	–	–	–	9	9	–	–	–	–	–	31	–	31
	B	88	–	40	94	1	34	854	2,349	8	–	–	101	–	3,312
	K	117	–	44	124	4	56	696	2,654	164	–	–	129	34	3,677
	M	42	–	8	44	6	17	4	468	65	–	–	35	7	579
	Total	269	–	92	262	22	118	1,554	5,471	237	–	–	297	41	7,600
1947....	G	24	–	–	–	12	12	–	–	–	–	–	34	–	34
	B	152	–	79	127	1	45	1,025	3,902	18	–	–	83	–	5,028
	K	124	–	49	106	4	54	678	3,833	287	–	–	92	18	4,908
	M	68	–	9	66	6	24	17	559	42	–	–	35	7	660
	Total	368	–	137	299	23	135	1,720	8,294	347	–	–	244	25	10,630
1948....	G	37	–	–	–	18	18	–	–	–	–	–	63	–	63
	B	209	–	113	143	1	58	1,108	5,801	14	–	–	143	1	7,067
	K	174	–	98	150	4	59	1,072	5,224	87	–	–	82	28	6,493
	M	65	–	17	66	3	23	87	809	12	–	–	36	12	956
	Total	485	–	228	359	26	158	2,267	11,834	113	–	–	324	41	14,579
1949....	G	44	–	–	–	22	23	–	–	–	–	–	83	–	83
	B	249	–	131	141	1	70	1,676	7,443	3	–	–	69	–	9,191
	K	210	–	163	224	4	67	1,338	6,879	31	–	–	54	23	8,325
	M	63	–	18	53	3	24	285	788	6	–	–	18	4	1,101
	Total	566	–	312	418	30	184	3,299	15,110	40	–	–	224	27	18,700
1950....	G	44	–	1	2	20	21	7	19	–	–	–	37	–	63
	B	251	–	135	147	1	67	2,941	4,289	1	–	–	59	–	7,290
	K	185	–	124	278	4	69	2,111	3,522	28	–	–	52	20	5,733
	M	64	–	19	50	2	21	296	512	9	–	–	24	5	846
	Total	544	–	279	477	27	178	5,355	8,342	38	–	–	172	25	13,932

Table 1 (continued)

Year	District	Number of fishermen	Number of gears: Trawls not specified	Herring trawls	Trawls other than herring trawl	Danish seines	Number of vessels	Catch (metric tons): Herring	Cod	Plaice	Dab	Flounder	Dabs + Flounder	Other fish	Total
951....	G	45	–	4	7	19	21	83	62	–	–	–	37	–	182
	B	359	–	183	181	3*)	83	4,074	3,856	–	–	–	45	–	7,975
	K	202	–	110	286	4	71	2,476	4,590	50	–	–	59	7	7,182
	M	52	–	17	53	3	20	134	467	13	–	–	33	4	651
	Total	658	–	314	527	29	195	6,767	8,975	63	–	–	174	11	15,990
952....	KS	4	–	4	4	–	1	111	47	–	–	–	–	–	158
	G	40	–	7	8	23	21	98	118	–	–	–	89	–	305
	B	312	–	134	166	–	84	3,151	5,251	2	–	–	75	–	8,479
	K	191	–	101	294	4	68	1,847	3,648	58	–	–	77	2	5,632
	M	51	–	12	57	3	20	57	772	37	–	–	64	4	934
	Total	598	–	258	529	30	194	5,264	9,836	97	–	–	305	6	15,508
953....	KS	4	–	4	3	–	1	160	41	–	–	–	1	–	202
	G	59	–	9	9	22	26	241	129	–	–	–	45	4	419
	B	291	–	168	192	–	83	4,370	3,270	1	–	–	58	–	7,699
	K	200	–	143	244	4	65	3,092	2,850	81	–	–	68	13	6,104
	M	54	–	15	59	9	22	90	708	28	–	–	43	5	874
	Total	608	–	339	507	35	197	7,953	6,998	110	–	–	215	22	15,298
954....	S	2	–	4	–	–	1	1	1	–	–	–	–	–	2
	KN	12	–	18	–	–	3	76	–	–	–	–	–	–	76
	KS	12	–	10	4	–	3	239	19	–	–	–	1	7	266
	G	51	–	14	8	20	24	658	109	–	–	–	50	14	831
	B	295	–	184	168	–	84	6,211	4,577	1	–	–	34	–	10,823
	K	204	–	138	249	6	73	2,226	2,477	96	–	–	56	11	4,866
	M	54	–	14	63	9	21	65	630	44	–	–	29	6	774
	Total	630	–	382	492	35	209	9,476	7,813	141	–	–	170	38	17,638
955....	N	2	–	5	–	–	1	1	–	–	–	–	–	–	1
	S	6	–	17	–	–	2	56	2	–	–	–	–	–	58
	KN	17	–	28	–	–	4	435	52	–	–	–	2	–	489
	KS	12	–	12	5	–	3	598	19	–	–	–	1	–	618
	G	64	–	27	5	20	26	1,068	174	–	–	–	24	38	1,304
	B	340	–	213	180	–	95	7,951	4,567	7	–	–	52	–	12,577
	K	221	–	133	258	4	70	1,887	3,382	188	–	–	65	77	5,599
	M	51	–	12	71	6	21	101	900	47	–	–	30	35	1,113
	Total	713	–	447	519	30	222	12,097	9,096	242	–	–	174	150	21,759
956....	Total	774	–	503	521	29	240	12,863	10,038	179	–	–	188	1,812	

*) Herring purse seines (only 1951).

atistics of Sweden flounders (*Pleuronectes flesus*) nd dabs (*Pleuronectes limanda*) were recorded to-ether during the period 1930 to 1955 and obviously efore 1930 also. These figures include not only the tch of the fishermen living on the Baltic coast of weden, but also the catch taken in the Baltic and nded at Baltic harbours by fishermen living on the wedish west coast (the counties of Halland and Bo-us). Trawlers (and during earlier years seiners) from e west coast of Sweden have participated in the shery in the Baltic (principally the southern part of e Baltic), since the early 1920's.

Swedish catches of cod in the Baltic

Figure 2 shows that the total Swedish catch of cod in the Baltic during the period 1915 to 1933 was comparatively small, and compared with the situation in recent years it remained at a comparatively uniform level. Since 1934 the catch of cod has increased very much, especially in the southern part of the Baltic. In the years 1950 to 1955, however, there seems to have been a decrease, at least in the southern Baltic. The Swedish catch of cod in this part of the Baltic during the spring of 1957 is, however, said to have been very big. Good year-classes and intensified fish-

ing have both been mentioned as the causes of this big increase. Good market prospects during, and a few years immediately following the last war have also influenced the fishery. It is also an important fact that, when the catches of flatfish declined in the 1930's, the fishermen of the south coast of Sweden began to use another type of trawl, bigger and better fitted to catch cod.

Swedish catches of plaice in the Baltic

Catches of plaice (Figure 3) are made by Swedish fishermen only in the southern part of the Baltic, as the abundance and the yields of plaice in the rest of the Baltic are negligible. In the early 1920's, Swedish fishermen started a fishery by Danish seine (later by trawl) on an accumulated stock of plaice in the southern Baltic. Earlier the Swedish catch of plaice in the Baltic (by means of gill-nets) had been very small. Now a very large increase in the catch of plaice followed. During the 1920's and the earlier part of the 1930's the total catch was large. During the later part of the thirties a very big decrease in the total Swedish catch of plaice in the Baltic followed, usually considered as resulting from overfishing. During the 1940's and 1950's the catch of plaice was generally small, yet in 1946, 1947, and 1955 it was comparatively good.

Figure 3. Plaice. Total Swedish catch in the Baltic.

Swedish catches of flounder and dab in the Baltic

Whereas plaice and dab are mostly confined to the southern part of the Baltic, flounder are more or less common also in the rest of the Baltic proper (Figure 4). During the periods 1919 to 1925 and 1939 to 1955 the total catch of flounder and dabs (taken together) by Swedish east-coast fishermen was bigger than the corresponding catch by Swedish south-coast fishermen. As was the case with the plaice the introduction of the Danish seine and trawl fishing in the southern

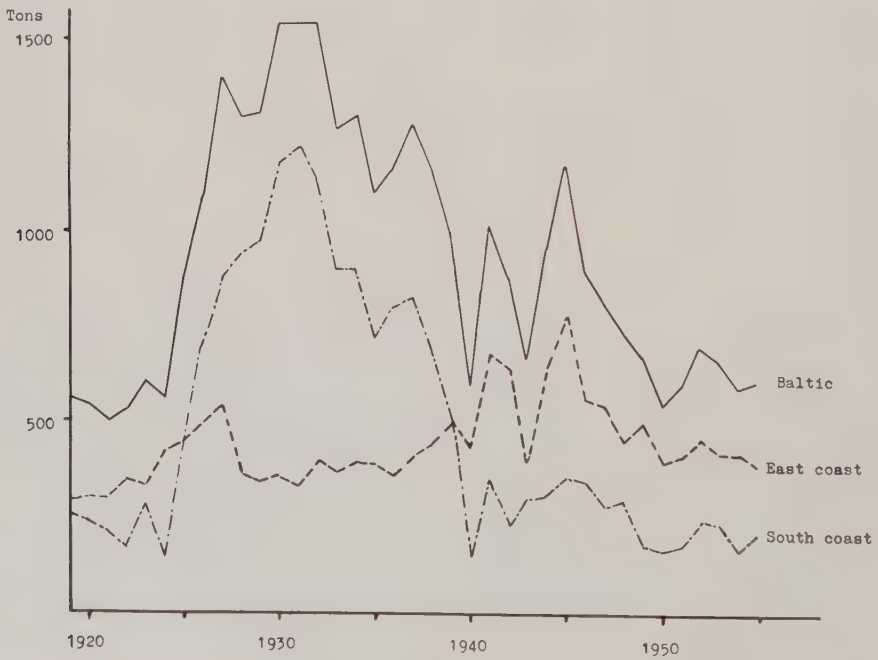


Figure 4. Flounder + dab. Total Swedish catch in the Baltic.
Information on dab., cf. p. 59.

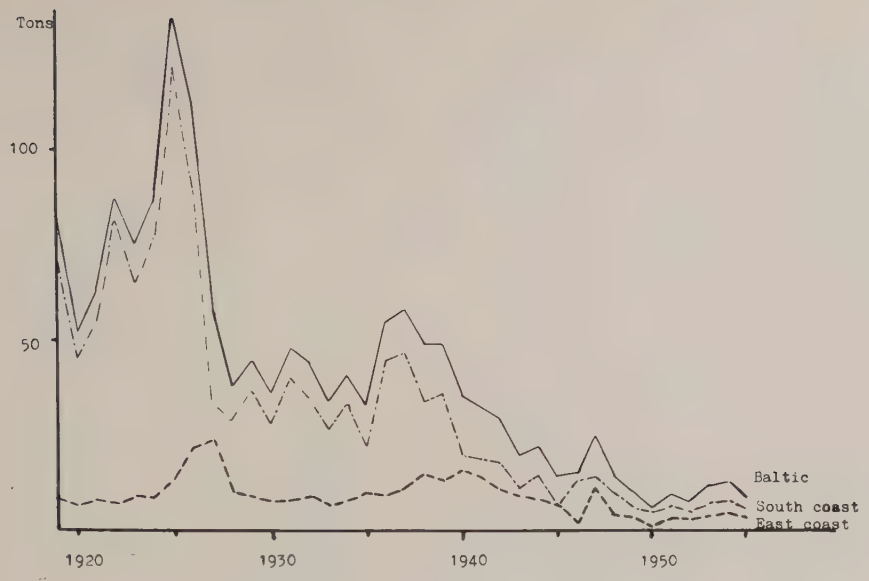


Figure 5. Turbot. Total Swedish catch in the Baltic.

altic in the early 1920's resulted in a large increase the catch of flounder and dab which, evidently as consequence of overfishing, was followed by a comaratively big decrease especially during the late 930's. During the period 1940 to 1955 the total catch flounder and dab by the south-coast fishermen reained at this comparatively low level, in spite of a ig increase in number and in the efficiency of the shing vessels, whereas the total catch of the east-coast shermen in the same period has been bigger than, or approximately the same level, as those of the 930's. The catch of flounder and dab was bigger on ie south coast than on the east coast during the eriod 1926—1938, but smaller during the period 939—1955. Since 1925, with exception of 1947 and 955 the total Swedish catch of flounders and dabs ogether in the southern Baltic was bigger than the atch of plaice. A considerable part of the Swedish atch of flounders in the Baltic is taken by gears other nan the trawl, especially gill-nets.

wedish catches of turbot in the Baltic

According to the official fishery statistics of Sweden ie catches in the southern part of the Baltic were rge during the earlier and middle part of the 1920's, ut they rapidly declined during the latter part Figure 5). A further decline followed during the peod 1940 to 1950. In the 1950's the catch was very nall in this district. The catch on the east coast was n a more uniform level during the period 1919 to 945. During the 1950's the catches of turbot have so been on a much lower level on the east coast than iose in the period 1919 to 1945. In the southern Baltic in rceent years the turbot has been a by-product of the trawl fishery. The turbot was here also, at least earlier, caught by special gill-nets having very big meshes. On the east coast the turbot is mostly caught as a by-product in gill-nets and other gear set to catch fish other than turbot.

Seasonal variations in the fisheries (Figures 6 to 9)

Seasonal variations in the fisheries are only recorded for the counties of Blekinge, Kristianstad, and Malmöhus in the official statistics of Sweden, the monthly catches of cod etc., being given. As the two last mentioned counties also have a coast on the Sound and the Kattegat, the monthly catch in question includes not only the Swedish catch in the southern Baltic but also quantities caught in the Sound and the Kattegat. The quantities for the Sound and the Kattegat are, however, small compared with the quantities taken in the southern Baltic.

Fishing on the various grounds

In Figures 2, 4, and 5, the Swedish catches in the Baltic have been divided into those for the south and the east coast. The plaice, and nowadays the dab, are almost exclusively fished from the south coast.

Catch per fishing unit

No figures of the yield per fishing unit are given in the official fishery statistics of Sweden. The yearly catch per fishing unit shown in Figures 10 to 12 has been obtained by dividing the catch by the number of

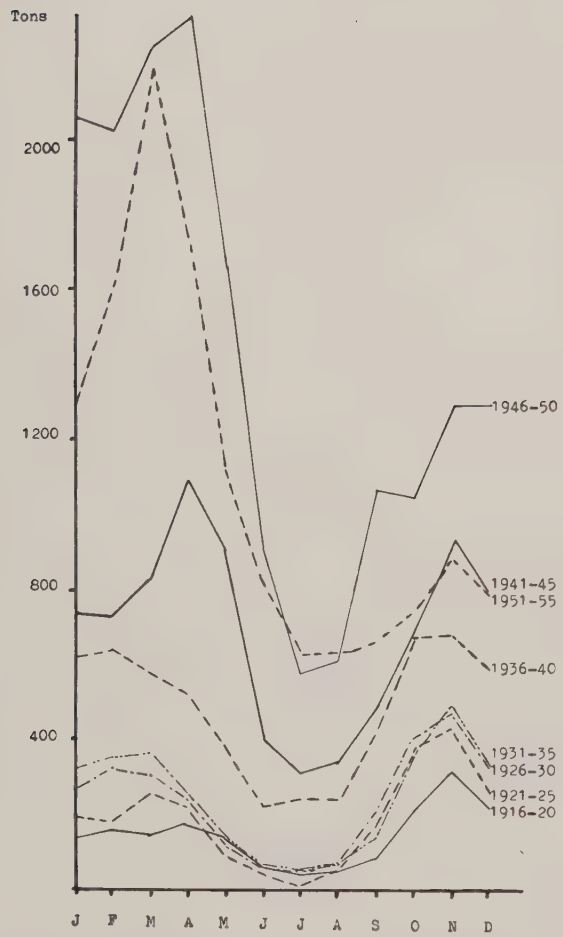


Figure 6. Monthly catch af cod taken by fishermen from the counties of Blekinge, Kristianstad, and Malmöhus in the period 1916 to 1955.

fishing vessels in the trawl fisheries for the counties of Blekinge, Kristianstad, and Malmöhus. The trawlers from these three counties may be regarded as fishing principally in the southern Baltic. These figures show that the catch per unit for flatfish was much larger in the 1930's than in later years. For the cod the catch per unit increased even to the end of the 1940's. It should be noted also that the tonnage and the horsepower of the vessels have increased since the 1920's. Since at least 1943 the Swedish trawlers have taken an increasing amount of herring. As will be seen in Figure 10 this catch of herring compensates to a considerable degree for the decrease in catch of cod per unit during the 1950's.

Figure 8. Monthly catch of flounder and dab. taken by the fishermen from the counties of Blekinge, Kristianstad, and Malmöhus in the period 1921 to 1955.
Information on dab, cf. p. 59.

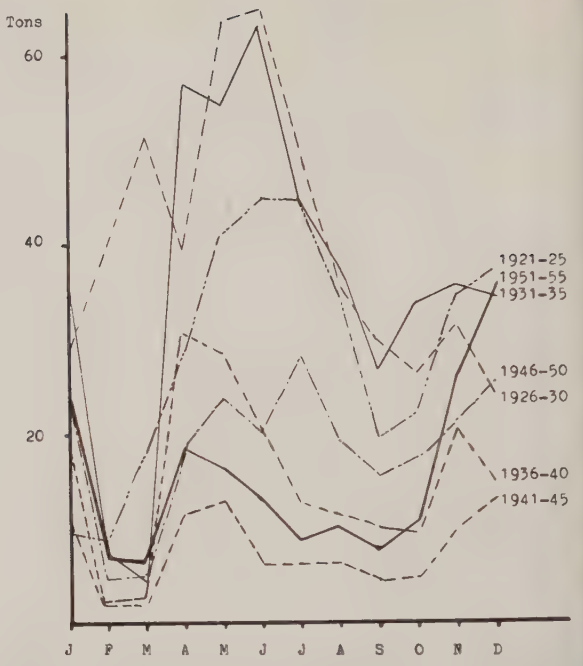


Figure 7. Monthly catch of plaice taken by the fishermen from the counties of Blekinge, Kristianstad, and Malmöhus in the period 1921 to 1955.

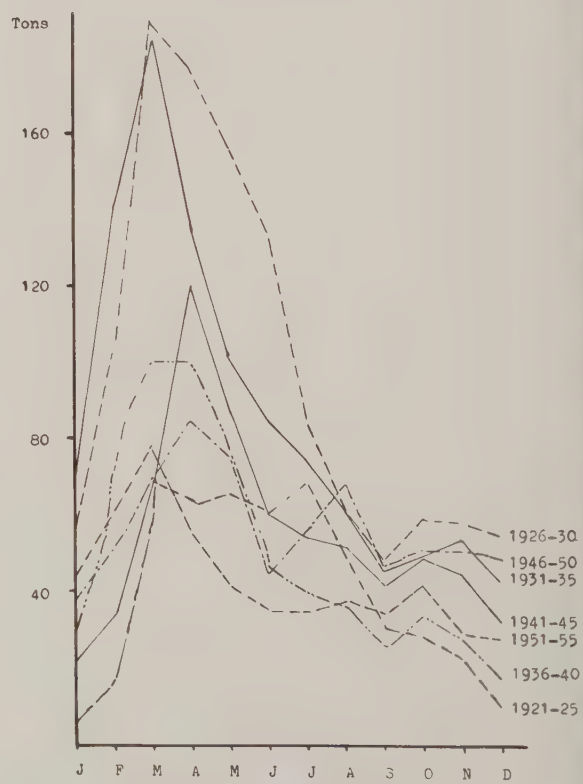
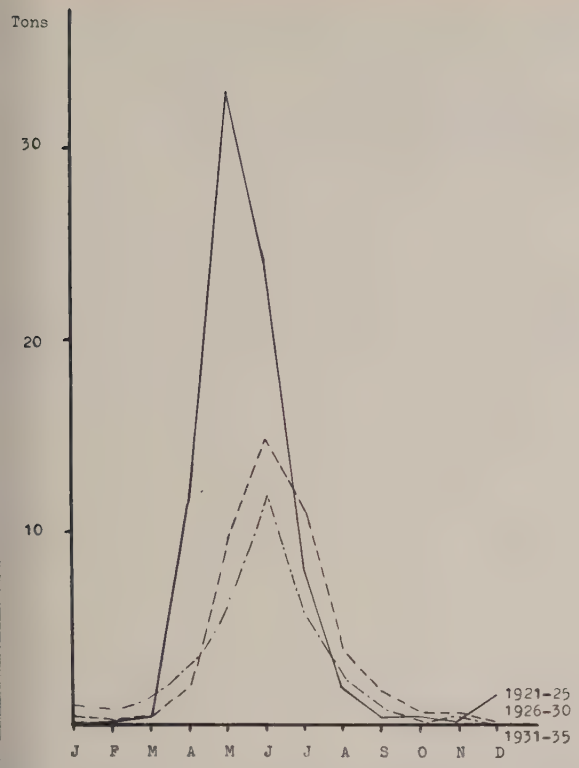
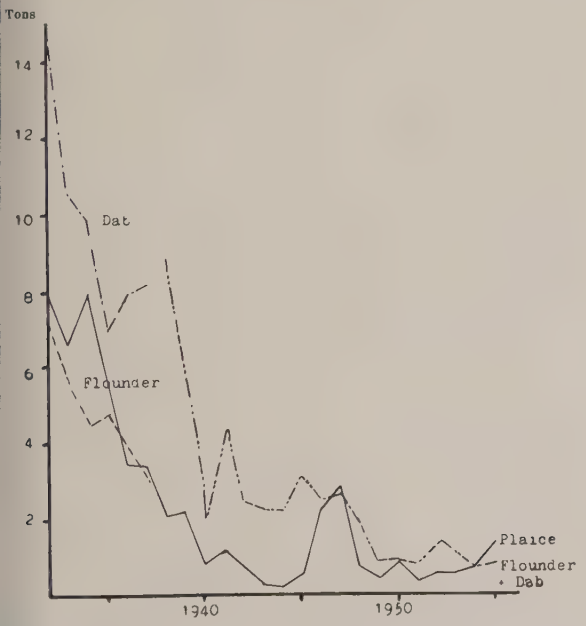


Figure 8.



igure 9. Monthly catch of turbot taken by the fishermen om the counties of Blekinge, Kristianstad, and Malmöhus in the period 1921 to 1935.



igure 12. Plaice, flounder, and dab. Annual catch per shing unit of the trawl fishery in the southern Baltic taken y vessels from the counties of Malmöhus, Kristianstad, and Blekinge.

Figure 10. Total annual yield per fishing unit of the trawl fishery from the counties of Blekinge, Kristianstad, and Malmöhus.

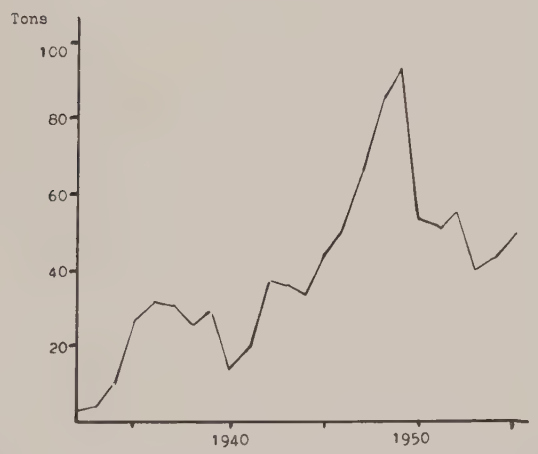


Figure 11. Cod. Annual catch per fishing unit of the trawl fishery in the southern Baltic taken by vessels from the counties of Malmöhus, Kristianstad, and Blekinge.

Swedish Regulations of the Fisheries in the Baltic

By Royal Proclamation of 21. December 1956 the following minimum sizes were applied in the Swedish fishery in the Baltic (sizes measured from tip of snout to extreme end of tail fin):—

Plaice.....	26 cm
Flounder (*Pleuronectes flesus*)....	20 -
Cod.....	30 -

Before the above-mentioned proclamation, another proclamation—of 23. January 1931—was in force. Ac-

cording to the last-mentioned proclamation, there was a close season in the plaice fishery during February and March and there were minimum sizes which were different for different parts of the southern Baltic. The minimum sizes in centimetres were:—

	SW part of the southern Baltic	Central part of the southern Baltic	Eastern part of the southern Baltic
Plaice.....	24	21	18
Flounder (*Pleuronectes flesus*)	22	20	18

For a few years special regulations have been in force aiming at the protection of the female plaice and flounder in the spawning season. According to the last Royal Proclamation on this question, it is prohibited during the period 1. January to 31. May to land female plaice and flounder, whose appearance distinctly shows that the hind tip of the ovary reaches behind the middle point of the distance between the tip of the snout and the extreme end of the tail.

For many years Royal Proclamations have been in force concerning the mesh size used in the Swedish trawl fishery (including Danish seines). In a Royal Proclamation of 21. December 1956, the minimum mesh size of trawls and Danish seines operated in the Baltic was fixed at 70 mm, with the exception of trawls used for catch of herring and certain other fishes.

6.

Swedish Cod Investigations in the Baltic

By

G. Otterlind

During the past two years Swedish investigations on the Baltic cod have included tagging experiments and sampling for measurements, etc. in different areas. The taggings took place mainly in the Åland Sea. Some trawling experiments concerning the selective effect of the mesh size of the cod-end have also been carried out in the southern Baltic, though on a rather small scale. The material collected has not been worked up completely; for instance, the age determination which is rather difficult. The present report will in the first place give a short review of our tagging experiments.

In the years 1955 and 1956 a total number of 827 cod were tagged in the Åland Sea (1955: 219; 1956: 525) and in the north-western Bothnian Sea (1956: 83, SE of Örnsköldsvik). This work was continued in 1957. Ebonite disks marked with Svö and a number and Lea tags with bridle and pin were used (591 and 236, respectively). The disks were fixed in the posterior part of the gill-cover; the Lea tags were fixed in the musculature in front of the first dorsal fin. The fish were caught with hand-lines and cod-lines and liberated immediately after being tagged and measured. Scale samples were also taken for age determination.

A comparison between the two tagging methods shows that the Lea tag is the most effective one. After 11 months 303 ebonite disks had given 12 recaptures, or 4 %. The corresponding value in the same experiment for 222 Lea tags was 32, or 14·4 %. This remarkable difference is no doubt due to the fact that the latter are easier noticed and also more "interesting" to the fishermen. In addition, the tagging mortality may possibly be higher when ebonite disks are used, especially for young fish.

In the Åland Sea we have a rather intensive cod fishery in a restricted area S and SE of the Understen light. The yearly landings amount to 1·5—2 mill. kg. The fish are caught with cod-lines, chiefly in depths of 200—250 m. The bottom here is not suitable for trawling. In the catches the age-groups from IV and upwards predominate. The length distribution is shown in Figure 1. During the period June—September the spawning of the cod is intensive in these depths. (In June 1957 we tagged 538 fish from the deep waters here.)

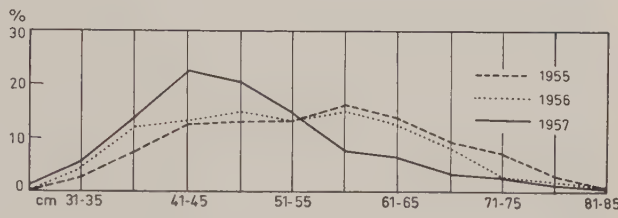


Figure 1. Length distribution of cod caught with cod-line in depths of 200—250 m in the Åland Sea during the years 1955 (4.—16. Aug.), 1956 (1. Sept.), and 1957 (23. May). 1,819, 678, and 1,796 fish were measured. The high percentage of the length groups 41—45 cm and 46—50 cm in 1957 may indicate a larger recruitment to the spawning stock in that year than in the two previous years; the samples are, however, from different seasons.

In summer, however, young cod are very common in the upper water layers of the Åland Sea and can be fished with hand-line from depths of about 25 to 40 m, off the coasts and skerries. All tagged fish in 1955 and 1956 were caught with this gear. Judging by our samples in August and September the cod from the upper water layers as a rule are juvenile or sometimes in maturity stage II (resting stage). The length distribution of our catches is given in Figure 2. Fish about three and four years old predominate. Figure 2 suggests that recruitment of the youngest fish caught was larger in 1955 than in 1956. From 1957 we have at present no measurements.

The recoveries from the experiments of the years 1955 and 1956 in the Åland Sea are shown in Figures 3 and 4. The total number by 1. August 1957 was 64 (20 and 44, respectively), or 8·6 %. The highest percentage the experiments have given with the Lea tags was 14·4 % in 1956—after 11 months (in 1955 only 14 Lea tags were used and they gave four recoveries in 12 months). It is striking that more than 30 % of our recaptures have been taken in the southern and central Baltic. The records give a picture of the fishing activity in time and area. The Swedish cod fishery is insignificant south of the Åland Sea to the waters west of Gothland. In the Gulf of Bothnia there is no cod fishery worth mentioning, except on a small scale in the deep water off the coast of Ångermanland. The most intensive fishery is carried on in the southern part of the Baltic. The absence of recoveries north of the Åland Sea area, exclusive of an isolated record off

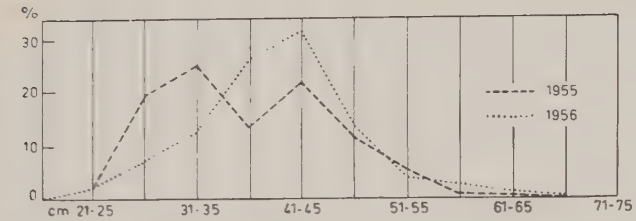


Figure 2. Length distribution of cod caught with hand-line in depths of about 25—40 m in the Åland Sea during the years 1955 (8.—29. Aug.) and 1956 (20. Aug.—4. Sept.). 548 and 579 fish were measured (cf. the text).

the Finnish coast might thus be explained to some extent as a result of low fishing activity. The stock of cod in the northern regions is usually very small. Single records of cod are, however, reported to be more numerous now than previously, even in the northern part of the Gulf of Bothnia.

The recaptures in the southern Baltic were made in the period February to June, most of them in April (five) after tagging in the preceding August and September. There is also one record for February 1½ years after tagging. The two recoveries in the central Baltic (Figure 4) were made in December and March. In the Åland Sea we have recoveries from every month of the year, except August and December. They are most numerous in September and October of the year of tagging. In 1957 there were 11 records here during the period May to July. The line fishery for cod is carried on throughout the year when it is not prevented by ice (usually one month in the year).

The material at our disposal does not enable any definite conclusions to be drawn regarding a possible difference between the young cod which migrate southwards and those which remain in the Åland Sea. Cod recaptured in the southern and central Baltic ranged between 30 and 49 cm in length when tagged. When recaptured three of them were in maturity stage IV and one in stage V, indicating spawning migration. The length range is approximately the same as that found in the Åland Sea during a corresponding period, namely, 31 (25)—47 cm. We have also received two specimens here in May and June in maturity stage V; at least two (probably more) were in stage I or II. In most cases, however, we have no information about the maturity stage of the recovered fish.

Our tagging experiment in the Gulf of Bothnia (82 cod tagged with ebonite disks in November and one in July 1956) has resulted in four recoveries; one in the tagging area, and three south of it in March to May 1957. Two of the latter had migrated about 50 naut. miles SSW and the third about 20 miles in the same direction. These records and the one from the Åland Sea found off the Finnish coast of the Gulf of Bothnia (see Figure 4) suggest a close relation between the cod populations here. The cod tagged at the coast of Ångermanland were large and, no doubt, mainly mature fish caught with cod-line in depths of 35—110 m. The length range was 40 to 76 cm. The

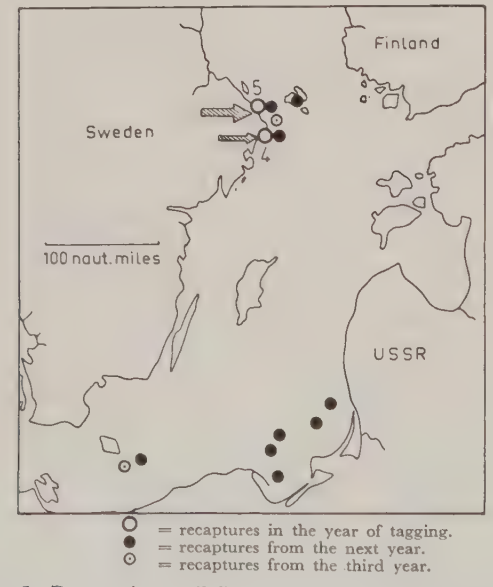


Figure 3. Recoveries until first August 1957, from the tagging experiment of 1955 in the Åland Sea. Arrows indicate the tagging localities. The figures show the number of recaptures of not individually marked fish, taken in the neighbourhood.

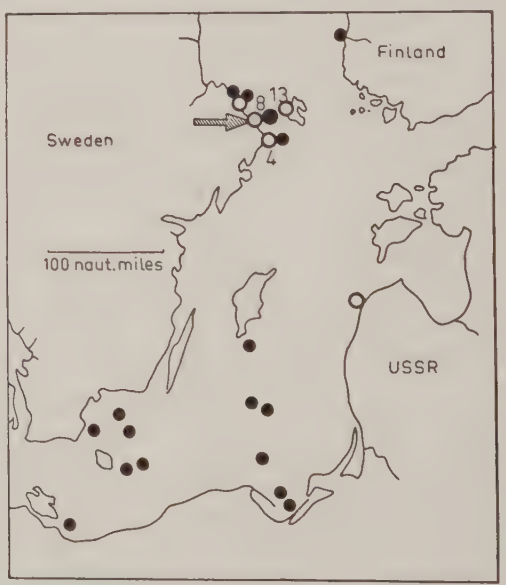
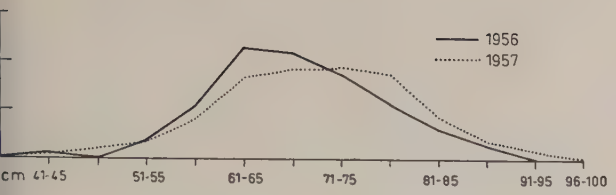


Figure 4. Recoveries until first August 1957, from the tagging experiment of 1955 in the Åland Sea. For legends, see Fig. 3.



igure 5. Length distribution of cod from the Gulf of Bothnia SE of Örnsköldsvik). On 17. and 18. July 1956, 113 fish ere measured which were caught with cod-line and cod-net a depth of about 100 m. In May (6.—28.) 1957, 525 fish ken with cod-line from depths of 30—80 m were measured.

od fishery is here based on the higher age-groups. Young fish are very scarce in the catches, even less requent than in the fishery of the deep Åland Sea. The length distributions of two samples from commercial catches are shown in Figure 5. In July 1956 ish in spawning stages were commonly noticed in a epth of about 100 m.

In the upper water layers of this area we took o catches at all with hand-lines in July. Judging by he length distributions the young cod are less tolrant than the old fish towards changing hydroraphical conditions in the northernmost part of the rea of distribution.

Though spawning is a regular phenomenon in the eep waters, hauls with plankton and stramin nets ave yielded no eggs or fry of cod during our invesgations in the Åland Sea and the Gulf of Bothnia. The same result had been obtained previously by Hessle in the twenties. He suggested that following the low salinity here, the development of the eggs took place on the sea bottom. The complete non-appearance of the 0-group, the low frequency of age-group I, and the results of the present tagging experiments indicate, however, that it is most likely that the cod population in these areas is recruited from the central and southern Baltic. Probably the immigrants belong mainly to age-groups I—II and to a large extent return southwards, at least for their first spawning period. It is possible therefore that no larvae develop from the eggs spawned by the cod in the Åland Sea and northwards. The deep waters might here be something like blind alleys with rich food resources, which in association with the hydrographical conditions induce cod mainly of the older age-groups to remain there for spawning. In all events the Åland Sea and adjacent waters must be important feeding grounds for the Baltic cod.

Judging by the present result of our tagging experiments migrations of Baltic cod are more extensive than it was earlier believed and the exchange between the areas is not unimportant. Continued tagging activity, especially with regard to the youngest age-groups (0—II) in the southern and central Baltic, is planned and recommended. Such experiments and further investigations on the spawning activity may solve the problem of recruitment to the stock of cod in the northern regions of the Baltic.

7.

Some Data on the Life History and Fishery of Cod in the Central Baltic*)

By

T. F. Dementjeva

The main USSR cod-fishing regions in the central Baltic are the Gothland Deep and areas adjacent to the Klaipeda-Ventspils part of the eastern coast. The biological characteristics of cod given in this paper have been obtained from samples taken from the above areas which yield the bulk of the Soviet catches of Baltic cod.

Table 1 shows the pre-war catches of cod in the central Baltic and it is based on the statistics of the cod fishery, mainly by hook and line, of the Latvian Republic. Since 1946, because of the expansion of the Soviet trawling fleet, the catches taken by this Republic amount to one-third of the total catch of Baltic cod in the USSR. The stock of cod in the central Baltic has greatly increased during the past two decades, as it has in other areas of the Baltic.

Table 1. Catches of cod for the period from 1924 to 1956
(in 100 tons)

Year	Total catch	Catch by Latvia	Year	Total catch	Catch by Latvia
1924...	–	12·6	1940...	129·0	69·0
1925...	–	24·7	1941...	–	–
1926...	–	14·5	1942...	–	–
1927...	–	11·3	1943...	60·9	42·1
1928...	–	11·5			
1929...	–	6·9	1946...	57·9	32·3
1930...	–	4·5	1947...	108·8	52·2
1931...	–	6·1	1948...	177·6	59·0
1932...	–	8·8	1949...	256·4	92·6
1933...	–	15·8	1950...	418·6	144·6
1934...	–	8·1	1951...	468·6	187·9
1935...	–	9·7	1952...	490·4	165·6
1936...	–	29·7	1953...	281·9	103·9
1937...	–	33·9	1954...	406·3	179·8
1938...	–	33·7	1955...	375·6	171·9
1939...	110·7	76·1	1956...	614·4	273·2

We know that this increase has been favoured by changes in the hydrographical condition of the bottom water in the deep basins of the Baltic, where the cod spawn (Alander, 1952; Jensen, 1954). Kändler (1954) has shown that cod eggs develop only at salinities above 10—11 ‰. From time to time a renewal of the water takes place, due to an intensive inflow from the North Sea, resulting in a higher salinity of the bottom water. The inflow of North Sea water has become more intensive since 1937 and 1938 and depends on complex processes of interaction between the hydrosphere and the atmosphere.

These changes in hydrographical conditions were far less marked in the feeding areas of cod, which are situated in shallower parts of the area. Mańkowski (1951) and Nikolaev (1951) have shown that warm-water species are now penetrating farther north in the Baltic, but there are as yet no data indicating an increase in the number of food organisms of the cod, especially of *Mesidothea entomon,* the chief component of the cod's diet. In any case, the food supply in the Baltic has proved to be sufficient for the greatly expanded stock of cod. It can, therefore, be concluded that in the past the abundance of cod was mainly limited by the conditions for reproduction. According to Kändler's and Chrzan's data from the southern Baltic and Tokareva's data from the Gothland Deep, some intra-specific food competition did occur, which affected the rate of growth, as shown by a comparison of the mean sizes of the age-groups in the different years.

Table 2. Mean sizes (cm) of basic age-groups of cod

Years	Age				Author
	3	4	5	6	
1931–33....	33·5	47·9	61·6	69·5	Kändler
1948–51....	39·7	46·5	54·0	63·8	Chrzan
1950.....	43·0	45·0	51·0	60·5	Tokareva
1956.....	38·5	42·0	52·0	–	Tokareva

The difference in mean size appears to be more marked in the older age-groups.

Changes in the growth-rate of cod are related primarily to changes in numerical strength. This has been established by similar work on the changes in growth and abundance of cod from various regions of the North Atlantic (Dannevig, 1954; Jensen, 1954; Rollefsen, 1954), as well as of many other species of fish.

The spawning of cod takes place in both the northern and southern parts of the Gothland Deep. The first maturity of cod occurs at 3 years of age but more

*) In this report the data from T. Dementjeva's report at the Joint Meeting of ICNAF, ICES, and FAO in Lisbon 1957, are used.

Table 3. Average catches of cod (kg) per one hour of trawling by months and years

Based on research fishing data, combined with the data presented by the Latvian Branch of the Institute of Marine Fisheries and Oceanography, concerning the different regions of the central Baltic)

Year of catch	Months										
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI-XII
1949 ..	167	145	135	334	299	186	170	117	154	119	132
1950 ..	158	165	259	298	252	193	135	118	143	94	113
1951 ..	115	222	242	174	195	146	105	113	134	133	117
1952 ..	161	247	327	283	199	144	110	102	147	118	150
1953 ..	124	150	145	138	100	85	130	120	114	130	135
1954 ..	80	170	220	132	90	89	73	97	80	70	72
1955 ..	120	142	210	184	100	97	65	90	170	60	75
1956 ..	117	133	270	235	205	110	130	128	125	126	155

Table 4. Age composition (%) of the catches of cod for the years 1946-56 during the spawning season

(Compiled from data presented by A. Prieditis, N. Sloka, T. Dementjeva, and G. Tokareva)

Year of catch	Age									Total
	1	2	3	4	5	6	7	8	9	
1946...	–	1·4	7·1	*31·3*	*37·8*	*17·2*	4·5	0·7	–	100
1947...	–	1·0	5·0	18·0	*31·0*	*22·0*	*13·5*	7·0	2·5	100
1948...	–	2·6	*47·7*	*31·1*	*14·1*	2·1	1·2	1·0	0·2	100
1949...	–	7·3	16·9	*49·8*	*22·4*	3·4	0·2	–	–	100
1950...	5·7	*9·4*	*38·1*	13·0	*28·0*	3·8	1·0	0·5	0·5	100
1951...	–	5·6	*37·4*	*36·7*	8·8	10·9	0·6	–	–	100
1952...	–	6·0	26·0	39·0	22·0	4·0	3·0	–	–	100
1953...	–	1·0	23·8	56·8	13·8	2·3	2·3	–	–	100
1954...	–	1·4	11·6	*47·9*	26·3	10·3	2·3	0·2	–	100
1955...	–	3·4	19·0	*39·0*	30·0	17·0	15·2	5·1	1·3	100
1956...	–	5·6	*34·0*	30·0	17·2	9·5	2·4	1·2	0·4	100
1957...	–	3·7	*38·0*	*42·3*	12·0	3·0	1·0	–	–	100

Table 5. Length composition (cm) of spawning cod in the central Baltic

(Compiled from data presented by A. Prieditis, N. Sloka, T. Dementjeva, and G. Tokareva)

Year	15/19	20/24	25/29	30/34	35/39	40/44	45/49	50/54	55/59	60/64	65/69	70/74	75/79	Total
1946.....	–	–	3	9	17	21	17	13	10	6	3	1	–	100
1947.....	–	–	1	8	16	19	19	15	11	6	4	1	–	100
1948.....	–	–	2	3	16	45	28	5	1	–	–	–	–	100
1949.....	–	–	3	15	37	23	12	6	2	1	1	–	–	100
1950.....	–	1	6	18	28	23	12	6	3	2	1	–	–	100
1951.....	–	–	2	20	26	24	15	8	4	1	–	–	–	100
1952.....	–	1	4	22	28	18	13	6	5	2	1	–	–	100
1953.....	–	3	7	24	36	20	7	1	1	1	–	–	–	100
1954.....	–	–	2	9	26	24	15	8	7	4	3	2	–	100
1955.....	1	4	8	17	23	17	11	6	5	4	2	1	–	100
1956.....	–	1	9	29	27	16	8	4	3	2	1	–	–	100
1957*).....	–	1	1	12	37	24	13	6	3	1	1	1	–	100

*) Preliminary figures.

often at 4 years. This accounts for the fact that in the catch composition of spawning cod, three, four, and five year-old fish are predominant, especially the four year-olds. As seen from Table 3, spawning reaches its highest peak in April and May.

It is known that cod form the densest concentrations at the time of spawning in April and May, that is, when the greatest catch per effort is recorded. Considering that the spawning concentrations are the most representative of stock conditions, our estimates of dynamics of stocks are related to the analyses of these concentrations.

Tables 4 and 5 show the dynamics of the spawning stock of Baltic cod during eleven years of exploitation by industrial fishing mainly in the Gothland Deep. It will be noted that at first the fishery took mainly the older age-groups, but gradually it exploited the younger ages. This was due to two reasons: (1) the presence in large numbers of the very rich broods of 1940 to 1942 which had only been feebly exploited by fishing, and (2) a great increase in the fishing fleet from 1950 onwards, together with relatively less abundant later

Table 6. Total and average catches of Baltic cod taken by the USSR

(After Prieditis)

Year	Total catch (100 tons)	Yearly average/ hour trawling (kg)	Average catch (kg) per hour trawling in spawning period (Feb.–June)
1948.....	177·6	180	205
1949.....	256·4	143	170
1950.....	418·6	134	185
1951.....	468·6	119	160
1952.....	490·4	137	169
1953.....	281·9	113	140
1954.....	406·3	122	152
1955.....	375·6	125	150
1956.....	614·7	164	197

year-classes. This resulted in a rise in the total catch of cod for the eastern Baltic and a simultaneous decrease of catch per hour of trawling (Table 6).

The lower indices of effectivity may be explained as follows: From estimates of the numerical strength of generations it may be assumed that along with the rich broods of 1940 to 1942 there was also a rich year-

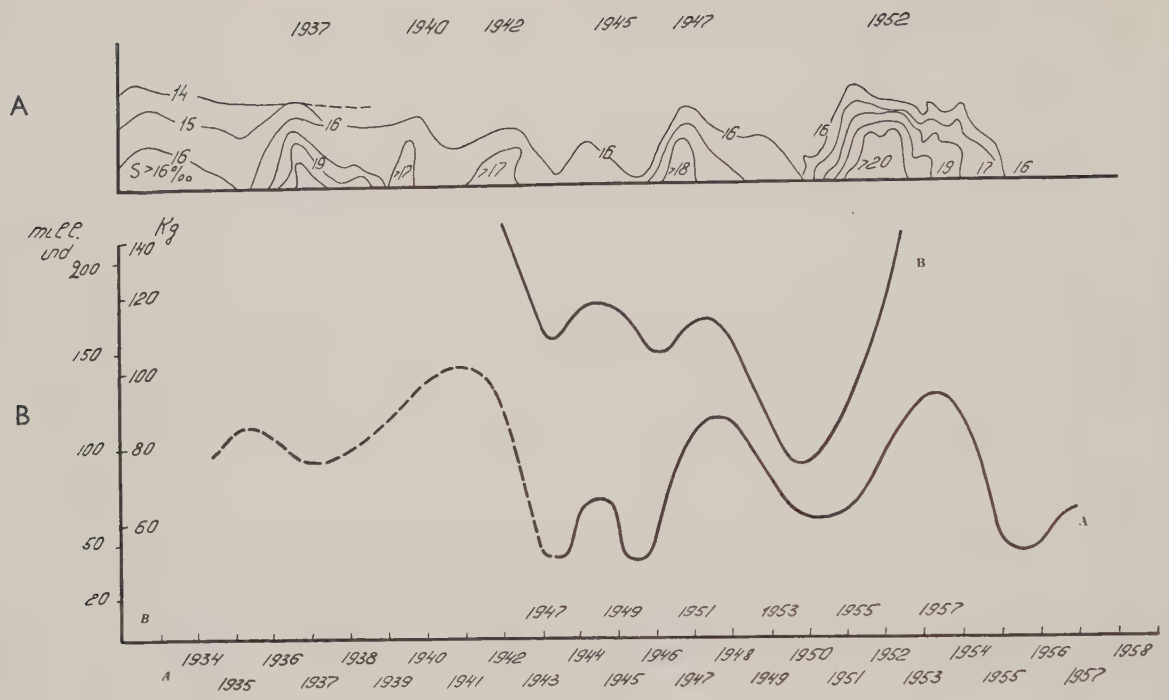


Figure 1. Comparison of changes in abundance of year-classes of cod (A) with salinity data of the near-bottom layers of the Bornholm Deep (after A. Glowińska) and with the data on catch per effort (B).

A. Strength of year-classes in millions of fish.
B. Mean catch per hour trawling (according to the data from the Dept. of Fishing Industry of Lithuanian SSR).

class in 1945 whose contribution to the commercial catches was very noticeable against the background of the weaker year-classes of 1944 and 1946. The next rich broods were those of 1947 to 1950, especially that of 1949.

The relative abundance of these year-classes however, was somewhat lower than that of the 1940 to 1942 classes. The relative difference between the two groups cannot be ascertained, for the number of trawlers varied greatly during this period.

The third period of rich broods (Table 4, 34 % of three year-old cod in 1956) begins in 1953. This may be seen also from data on quantitative records of young cod, which confirm the great numerical strength of the 1953 and 1954 year-classes. Further evidence is presented by the average catch per one hour of trawling, which during the spawning season of 1956 was higher than the average for the years 1953—56 (Table 7). The intensity of fishing remained unchanged during these years.

A further consideration of the data shown in Tables 4 and 5 leads to the following conclusions: during the whole period of fishing from 1940 onwards increases in the yield of cod were observed in the

Table 7. Average catches (kg) per hour's trawling on the spawning grounds, by months

(After Prieditis)

Year	Months					Region	
	II	III	IV	V	VI		
1956.....	116	230	275	250	120	Gothland Deep	
1953–56..	124	227	202	184	107	-	-

periods 1940/42, 1947/50, and 1953/54. Adding the period 1937/38, already known as the first period of high productivity which greatly increased the stock of Baltic cod, it may be observed that all these periods coincide, more or less, with periods of intensive inflows of water from the North Sea.

In a paper presented to the 45th meeting of the ICES by A. Glowińska, salinity data for the period 1934/57 were given for the Bornholm Deep; these data were compiled and treated in a uniform manner and present evidence of changes in salinity. The strength and period of the inflow of North Sea waters into the Baltic can be assessed from the changes in the depth of the 16 ‰ isohaline.

It is seen from Figure 1, where A. Glowińska's data are used merely for the near-bottom layers of the

Bornholm Deep, that periods of increased salinity coincide with increase in strength of certain year-classes, as has already been mentioned.

The generation curve, curve A, is based on the Soviet catches. The generations are estimated in millions of fish. It must be noted that rich year-classes were observed for two or three successive years. This is also indicative of some similarity of hydrographical conditions in the deep water, following an ample renewal of the waters.

Abundance of two or three successive year-classes suggests that survival of the eggs is one of the decisive factors which, at the early stages of development, determine fluctuations in the abundance of the year-classes. During rich periods there are, of course, differences in the feeding conditions of the larvae; abundance, however, always remains at a high level. Consequently, abiotic factors can be considered as immediate and decisive, determining the order of abundance of a year-class, whereas the feeding conditions of the larvae apparently determine future minor differences in their abundance.

Fluctuations in abundance of cod are so strongly pronounced that they affect the distribution and density of the shoals and consequently the catches. In Figure 1 curve B shows the mean catches per hour's trawling. Since it is known that the four year-olds form the main commercial part of each estimated year-class (curve A) the effort curve is accordingly moved 4 years to the left. It can readily be seen that both curves supplement each other.

The sharp fall in the catch per effort in 1953 apparently results from the fisheries for young cod in the previous years.

The commercial stock was greatly reduced by the removal of young fish. On the feeding grounds young fish were taken mainly in the autumn in quantities amounting to 40 % of the total catch of cod.

This resulted in an abrupt decrease in the weight of the catch, because the amount of older age-groups naturally was diminished in the years following the intensive fishing of the young ones. As shown by the mortality curve (Figure 2) the exploitation of the broods from 1947 to 1950 by fishing came to an end much more rapidly than that of the 1941 and 1942 broods. If we also take into account a decrease in the density during the years when the most important age-groups were represented by less abundant year-classes, it is easy to understand why the average catch per hour declined during the years 1950 to 1955. We believe that the mean and total catch in 1953 was also adversely affected by a dispersion of the spawning shoals over a greater area during the height of fishing, March and April, as has been indicated earlier by Lagunov.

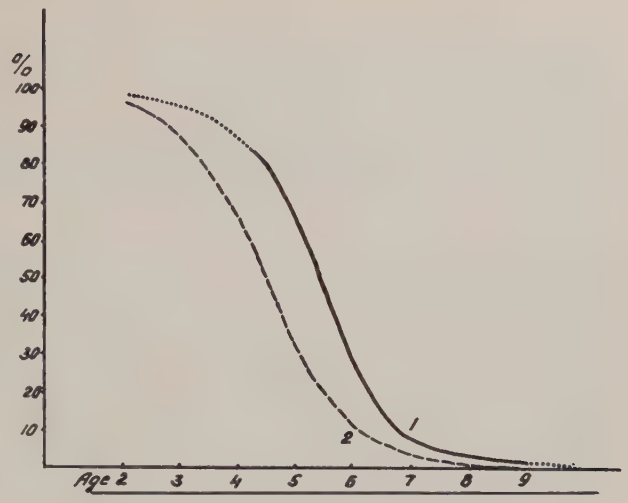


Figure 2. Mortality curve of the year-classes.
(1) 1941 and 1942 year-classes.
(2) 1947 to 1950 year-classes.

The decrease in average catch per unit of fishing effort, together with the changes of the age composition during the same period (1950—55), is indicative of a rather intensive exploitation of the stock of cod, as already observed by several Polish authors. Thus, according to Elwertowski (1955), the annual mean catches per hour of trawling were:—

Year	1950	1951	1952	1953
Mean catch in kg	151	126	118	96

We see that the general trend is the same as in the average catch per hour in the central Baltic. Therefore the considerations stated above are applicable in both cases. Consequently, it may be assumed that the catch of young cod is relatively heavy and that it affects the total catch and the composition of the stock of cod in the Baltic. But does this imply a depletion of the population as a whole? Let us consider the following biological features of the population:

(a) Baltic cod are characterized by a relatively short cycle of life and an early onset of sexual maturity, sometimes in the third year and usually in the fourth year of life, so that it can be considered as a species possessing a high reproductive capacity.

(b) A comparison with the material available, of the numbers of spawners and their offspring disclosed no quantitative relationship of these values for the Baltic cod. Thus if we compare the catch of cod with the strength of the year-classes (at a constant intensity of fishing) we find that the years with the highest catches (1951, 1952, and 1956, see Table 3 and Figure 1) were years that yielded the poorest broods; the catch reflects the number of spawners, since two-

thirds of the fish are caught on the spawning grounds. (c) There remain, however, relatively large numbers of spawners because many spawning grounds cannot be exploited due to the rocky bottom.

The above-mentioned features show that the decisive importance of recruitment is unaffected by density, i. e. is uninfluenced by removal of spawners by the fisheries.

When actual depletion sets in the rate of recruitment steadily decreases, even when no abrupt changes occur in breeding, development, and feeding conditions. But in the case of the Baltic cod, the diminished recruitment corresponds solely to poor year-classes (three year-old cod of the 1946, 1951, and 1952 year-classes; see Table 4), born in years of low salinity. This means that the abundance of Baltic cod depends mainly on the conditions for embryonal development, but an excessive exploitation of young age-groups may result in a decrease of catch/weight and thus impair the profitableness of the fishery. This can be prevented by regulation of commercial fishing.

The best way to save the young cod is to enlarge the mesh of the trawl and to prohibit (except the Danish seine for flounders) trawling with any trawling gear in depths less than 20 m. Yearling cod usually concentrate at this depth, while the two year-old fish are spread deeper and are often encountered in the areas of concentration and feeding of commercial cod (Khaldinova). In areas of intensive inflow of fresh water, such as Klaipeda and Ventspils, small fish occur at depths of 60 to 70 m. On the other hand, it is difficult as yet to close areas for trawling in depths exceeding 20 m.

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8.

Characteristics of the Fishing Stock of Flounder in the Central Baltic

By

K. A. Zemskaya

Among the representatives of the flatfishes occurng in the Baltic, flounders alone are of great imortance to the fisheries of the USSR. They are ught in Estonian and Latvian waters and in the ntral Baltic, and in the south-eastern Baltic they are ught as a by-product of the cod fishery by trawlers the Lithuanian Republic and the Baltic Fishing rust (Kaliningrad). The catches of flounders durg the period 1925 to 1956 are shown in Table 1.

The main fishing gear used for flatfish is a flatfish ine (a type of "snurrevod" or Danish seine), but llowing the development of the trawl fishery for d, a considerable portion of the landings of flatfish as been produced as a by-product of that fishery.

The catches of flatfish vary considerably according seasons and localities, and in the Estonian SSR, the lk of the fish is caught in the summer months, June, ly, and August. Table 2 shows the seasonal catches flounders.

In the waters of the Latvian SSR the flatfish tches extend over the period from May to Novemr (Table 3), the greatest yields being in June, July, ugust, and September and during this period, over % of the annual catch is taken in those waters. fter spawning, the flatfish migrate from the depths to e nursery grounds in the shallow waters, on the nks and in the coastal area.

As Betesheva and Kulikova reported (1953), flounrs feeding in the waters of the Estonian and Latvian SR appear to belong to the Gothland stock (spawng in the Gothland Deep), but those caught in the uthern Baltic of the Lithuanian SSR seem to belong Gdańsk or Bornholm stocks. Thus, the flounders of the central and southern parts of the Baltic are divided, in accordance with the location of the spawning grounds, into three stocks, namely, those of Gothland, Gdańsk and Bornholm.

Table 1. Catches of flatfish in the waters of the Soviet Baltic (in 100 kg)

Years	Total catches	Estonian SSR	Latvian SSR	Lithuanian SSR
1925	14·4	–	14·4	–
1926	16·1	–	16·1	–
1927	11·8	–	11·8	–
1928	8·7	–	8·7	–
1929	15·4	–	15·4	–
1930	22·5	5·2	17·3	–
1931	25·7	5·9	19·8	–
1932	25·1	7·7	17·4	–
1933	31·8	6·4	25·4	–
1934	24·4	5·4	19·0	–
1935	16·6	4·4	12·2	–
1936	22·9	6·1	16·8	–
1937	35·9	12·1	23·8	–
1938	33·4	10·6	22·8	–
1939	10·6	10·6	–	–
1940	9·2	9·2	–	–
1942	3·9	3·9	–	–
1943	8·6	3·3	5·3	–
1945	7·2	1·9	5·3	–
1946	13·1	4·4	8·6	0·1
1947	18·5	8·5	10·0	–
1948	18·2	9·2	8·6	0·4
1949	26·1	12·2	12·9	1·0
1950	21·9	10·9	9·7	1·3
1951	28·5	13·1	14·6	0·8
1952	28·5	9·5	16·7	2·3
1953	23·2	9·8	12·3	1·1
1954	22·5	11·7	10·0	0·8
1955	33·4	17·2	14·7	1·5
1956	30·1	15·9	12·8	1·3

Table 2. The catch of flounders in the waters of Estonia in 100 kg (After Mikkelsaae)

Months	Jan.	Febr.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
verage catch 1932–40	10·7	15·7	17·0	43·8	423·9	1,871·4	2,839·7	1,823·8	878·8	90·3	32·1	12·0
	0·1	0·1	0·2	0·5	5·2	22·5	34·6	21·8	13·0	1·5	0·4	0·1

Table 3. The catch of flounders in the waters of Latvia as percentages (After Betesheva and Kulikova)

Months	Jan.	Febr.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
verage catch 1935–48	–	–	–	–	2·6	19·3	24·8	28·9	16·7	6·4	0·9	–
52–56	1·0	1·0	4·5	3·4	4·5	17·7	15·5	14·9	14·5	8·2	3·5	11·3

Table 4. The age composition (%) of flounders caught in the region of Ventspils

Age Years	1 +	2 +	3 +	4 +	5 +	6 +	7 +	Authors
1948...	0·4	20·5	58·9	19·5	0·7	–	–	Betesheva and
1949...	–	3·9	32·6	47·0	16·0	0·5	–	Kulikova
1955...	–	2·1	41·3	29·5	17·4	7·5	2·2	Pokrovskaya
1956...	–	0·6	3·6	48·8	33·7	12·7	0·6	Shurin
1957...	–	0·3	11·8	36·7	38·3	10·0	2·9	Zemskaya

Apart from these three stocks, there are also some other stocks of flounders inhabiting the coastal waters (Hessle, 1930; Kändler, 1935) and spawning close to the shore. Their eggs are smaller than those of flounders spawning in the deep waters and their development takes place in the bottom layer and not near the surface as it does for offshore flounders. As stated, coastal flounders grow more slowly and are mainly smaller than those occurring off shore.

In the Gulf of Finland flounders spawn during the period late May to early July; in the Estonian waters they spawn from April to June, and in the region of Ventspils-Liepaja in April and May.

Females attain sexual maturity in their fourth year of life (Betesheva and Kulikova, 1953; Kändler, 1935) but the males are ready to spawn at the age of three years. Their rates of growth are somewhat different, the males being smaller than the females of the same year-class.

The age composition of flounders has been studied irregularly, nevertheless the available data, taken for a number of years in the region of Ventspils, permit of some comparisons.

It will be seen from Table 4 that the older age-groups have increased in importance in recent years. This has also been mentioned by Mulicki (this volume) for the period 1945 to 1949.

By analysing the average sizes of the age-groups of the flounders caught in the vicinity of Ventspils during these years and comparing them with those caught in the previous years, it is obvious that the growth-rate has fluctuated considerably.

Table 5. The length (cm) of various age-groups in the commercial catches off Ventspils

Age Years	1 +	2 +	3 +	4 +	5 +	6 +	7 +	Authors
1909...	13·4	16·7	19·3	23·6	–	–	–	Suvorov
1946...	–	20·9	23·0	25·5	28·8	–	–	Judanov
1948...	12·5	18·7	22·5	25·1	28·3	–	–	Betesheva
1949...	–	16·0	21·0	22·8	25·1	28·3	–	Kulikova
1955...	–	20·0	22·8	25·5	26·6	28·3	30·8	Pokrovskaya
1956...	–	–	23·0	24·3	26·3	27·6	–	Shurin
1957...	–	–	23·5	25·4	27·4	28·7	30·2	Zemskaya

Table 6.

The area covered by the regulations	The mesh size in trap nets and haul seines (mm) knot to knot			The mesh size in nets (mm)	The total length of body (cm)
	Cod-end	Shoulders	Wings		
Irben-Strait, the Gulf of Riga and the Gulf of Finland.....	40	44	50	46	17–18
The waters of the Baltic off the Latvian SSR (south of Ventspils)	50	60	70	60	22*)

*) This also seems advisable since at this length (average size of 3 year-olds) the flounder switches over to molluscan feeding, and as this food is not also consumed by other species, they improve considerably in condition (greater weight, fat content, fecundity, etc.).

The fact that the catches of flounders in the Baltic in recent years continued to be at a relatively high level as the older age-groups gradually became dominant suggests that the stock of flounders has not decreased. It is not likely that the 1953 and 1954 year-classes were abundant.

With a view to preserving the stocks of flounders, fishing regulations include certain size limits for the meshes (knot to knot) and also for the fish. These are shown in Table 6.

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9.

Selection of Baltic Cod by Cod-Ends of Different Materials

By

W. Cieglewicz and W. Strzyzewski

In connexion with the planned protection of the uvenile cod of the Baltic, investigations on the selec-ivity of trawl nets used for the capture of this fish in he Baltic have become a necessity. Such investigations re fundamental in establishing the minimum sizes of net meshes. The *ad hoc* Committee appointed in 1955 by the Permanent Commission of the International Fisheries Convention in London indicates in its re-port that the minimum size of net meshes is the most effective means of protection of fish and leads to in-reasing yields. The necessity for investigations of the electivity of the trawl with regard to the Baltic cod was all the greater since up-to-date investigations arried out by European and American research workers mostly concerned the gadoid fish: haddock nd whiting. These investigations were also carried ut in the North Sea or in the northern Atlantic and rctic waters, the Baltic being totally neglected. Our nvestigations started in the spring of 1956 and were ontinued in 1957. They were conducted from the re-earch vessel m/t "Michal Siedlecki" (length, 24·1 m; eam, 6·4 m; draught, 2·2 m and 225 h.p.). The south-astern Baltic and especially the Gdańsk Bay (Figure) were the areas chosen for investigation.

A method similar to that applied by Davis (1934) was adopted by us. The exterior of the trawl cod-end was covered by a net with smaller meshes. In our ex-periments we did not apply any hoop to stretch the over of the cod-end as did Davis, because it appears hat the pressure of the water passing through the od-end and cover during the trawling operation trains the latter sufficiently. Owing to this, there is a ree area between the cod-end and the cover in which he fish, which escape through the cod-end meshes, ccumulate. In Figure 2 the trawl used in these in-estigations and also the manner of attaching the over are shown.

The cover was made of cotton net No. 40/24 and he size of the meshes was 32 mm (gauge measure). The od-ends were made of cotton, hemp, manila, and isal (the details are given in Table 1). The hauling peed was 2·5 to 2·8 knots, the duration of every haul bout 3 hours. After every haul the meshes of the

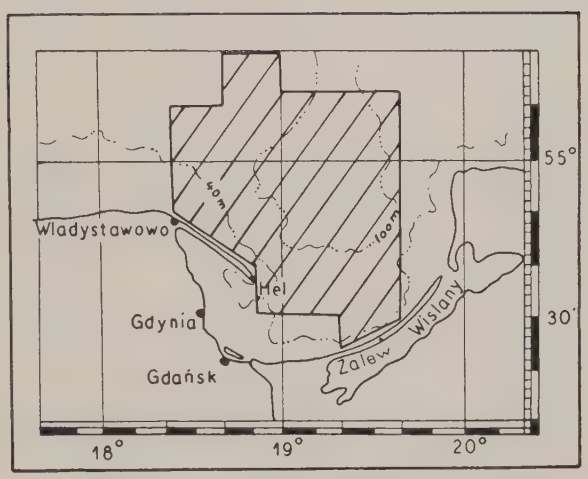

Figure 1. Locality of the experiments.

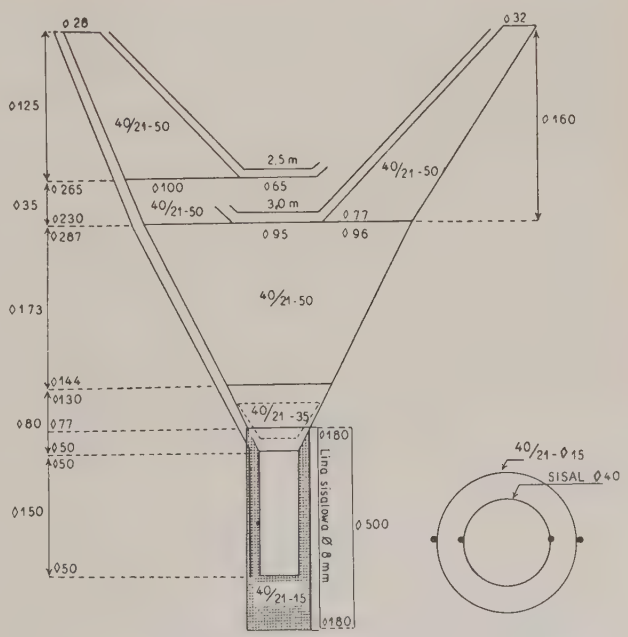

Figure 2. The type of trawl described, with cover.

Table 1. Mesh selection data for Baltic cod

Date	Apr.–May 1956	May 1956	June 1956	July 1957	Apr.–May 1957	Sept. 1956 Apr.–July 1957
Locality	Deep of Gdańsk	Deep of Gdańsk	3–10 sm N of Rozewie	Bay of Gdańsk	Deep of Gdańsk	Bay of Gdańsk
Material	Cotton 40/24	Cotton 40/24	Cotton 20/54	Hemp	Manila	Sisal
Diameter of twine, mm (wet)	1·13	1·13	2·96	2·15	1·78	2·89
Mean cod-end mesh size, mm	67·4	75·4	73·1	74·7	72·1	67·3
Number of hauls	4	1	5	3	4	7
Number of fish caught (cod-end + cover)	4,325	1,350	7,120	1,484	7,054	7,425
Number of fish in cover (%)	563(13·0)	265(19·6)	1,574(22·1)	318(21·4)	1,589(22·5)	1,300(17·5)
50% selection length, cm	25·5	28·2	22·3	27·2	24·3	20·2
Span of length between 25% and 75% points, cm	3·9	7·0	5·9	3·4	4·5	9·1
Selectivity factor	3·7	3·7	3·1	3·6	3·4	3·0

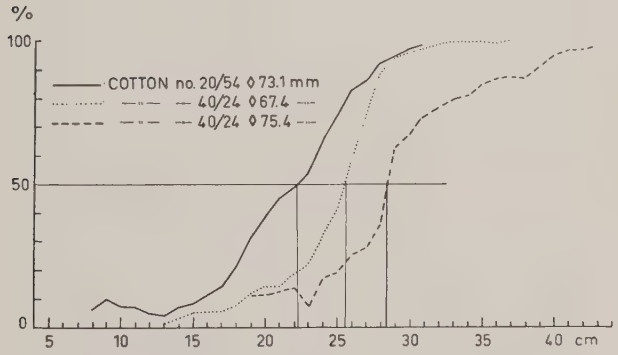

Figure 3. Selection curves for cotton twine.

cod-end were measured in a wet state. The measurements were made by means of a gauge of Polish construction, exerting a horizontal pressure equal to 4 kg (Strzyzewski and Zaucha, 1957). The cod-end meshes, made of fine cotton twine, were measured with horizontal pressure of 2 kg. Thirty meshes were measured each time in different parts of the cod-end and the mean size then determined. Both the lengths of the fish captured by the cod-end and the lengths of the fish which were retained in the cover, were measured.

The relation between the number of fish belonging to the various length groups retained in the cod-end and the number of fish which passed to the cover, gives an idea as to the selectivity of the net. The relation between the length of fish at the 50 % selectivity and the size of the meshes is known as the selection factor. These values, together with other data are given in Table 1.

Twenty-four hauls were made and 28,758 cod were measured. A detailed comparison between the lengths of fish caught in every experiment, together with the percentage relation of the number of fish retained in the cod-end and the total number of fish in the cod-end and the cover are given in Tables 2 to 7. The curves for selectivity given in Figures 3 and 4 were drawn on the basis of the above data. From these curves and the length of the fish at the 50 % selectivity point and the calculated selection factors, it may be concluded that cod-ends of fine cotton twine No. 40/24 are most selective. A hemp cod-end is slightly less selective and a manila cod-end distinctly less selective. Still cod-ends made from coarse cotton twine No. 20/54, as well as sisal, were the least selective.

The properties of the raw material, the thickness, the construction, and the elasticity of the twine are responsible for these differences. The size of the mesh does not seem to influence the value of the selection factor. This is confirmed by the results obtained, when using cod-ends made of the same cotton twine (No. 40/24), the meshes of which were in one case 67·4 mm, and in the second 75·4 mm in size (gauge measurements). The selection factor calculated for both cod-ends was exactly the same and amounted to 3·7.

An example of the various selectivities of cod-ends produced from the same material but from twines of different thicknesses and construction, may be seen in results obtained with cod-ends made of fine cotton twine No. 40/24 and a coarse cotton twine, No. 20/54.

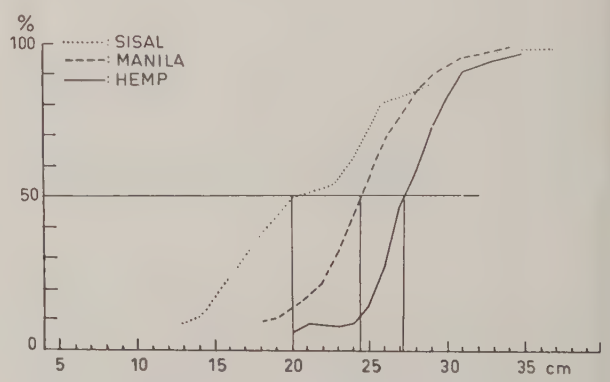

Figure 4. Selection curves for sisal, manila, and hemp.

Table 2. Length-frequency distribution of cod (Cotton No. 40/24, mesh size 67.4 mm)

Length, cm	Number of fish in			% in cod-end (smoothed)
	Cover	Cod-end	Cod-end + cover	
6.....	1	–	1	–
7.....	2	–	2	–
8.....	–	–	–	–
9.....	9	–	9	–
10.....	12	2	14	7·2
11.....	25	2	27	8·2
12.....	32	1	33	4·2
13.....	40	1	41	1·8
14.....	45	–	45	3·7
15.....	41	4	45	5·5
16.....	36	3	39	5·5
17.....	29	–	29	6·2
18.....	24	3	27	8·0
19.....	20	3	23	12·4
20.....	33	5	38	14·4
21.....	34	7	41	14·5
22.....	32	5	37	18·9
23.....	31	11	42	22·6
24.....	33	13	46	32·4
25.....	28	21	49	41·4
26.....	15	17	32	58·2
27.....	9	33	42	74·1
28.....	6	58	64	88·0
29.....	4	76	80	93·5
30.....	9	170	179	95·7
31.....	5	174	179	96·9
32.....	3	231	234	98·4
33.....	1	177	178	99·3
34.....	–	244	244	99·5
35.....	2	285	287	99·6
36.....	1	284	285	99·4
37.....	1	235	236	99·7
38.....	–	200	200	–
39–79..	–	1,497	1,497	–
Total..	563	3,762	4,325	

The selection factor for the coarse twine was 3·1 differing considerably from the factor for a cod-end made from fine cotton twine (3·7). The selection factor for the coarse twine is closer to the selection factor (3·0) for a sisal cod-end. It seems that more exact investigations are required to explain these differences. The selection factor for manila is 3·4 and it is thus higher than the factor determined for sisal (3·0). Since, however, the thickness of the manila twine was 1·78 mm and that of the sisal twine 2·89 mm it may be supposed that if the thickness of the twines was the same, the selection factor of the cod-ends would be more similar.

The selectivity of the hemp cod-end is relatively good. In spite of the fact that the thickness of the hemp twine (2·15 mm) is greater than that of the manila (1·78 mm) the selection factor of a hemp cod-end (3·6) is higher than that of a manila cod-end. This is distinctly influenced by the elasticity of the twine. This elasticity is better in the case of hemp than in manila.

Table 3. Length-frequency distribution of cod (Cotton No. 40/24, mesh size 75.4 mm)

Length, cm	Number of fish in			% in cod-end (smoothed)
	Cover	Cod-end	Cod-end + cover	
5.....	–	–	–	–
6.....	–	–	–	–
7.....	–	–	–	–
8.....	–	–	–	–
9.....	1	–	1	–
10.....	3	–	3	–
11.....	1	–	1	–
12.....	9	–	9	–
13.....	6	–	6	–
14.....	5	–	5	–
15.....	5	–	5	–
16.....	5	–	5	–
17.....	4	–	4	–
18.....	5	–	5	–
19.....	9	1	10	11·6
20.....	3	1	4	11·6
21.....	4	–	4	13·0
22.....	6	1	7	14·2
23.....	4	–	4	7·5
24.....	11	1	12	17·9
25.....	6	5	11	29·8
26.....	9	5	14	35·4
27.....	12	4	16	38·0
28.....	14	16	30	46·3
29.....	13	20	33	62·8
30.....	13	38	51	67·2
31.....	18	36	54	73·7
32.....	16	64	80	76·4
33.....	8	38	46	79·2
34.....	18	54	72	80·8
35.....	15	84	99	84·4
36.....	6	85	91	86·7
37.....	12	55	67	87·2
38.....	9	57	66	86·7
39.....	5	58	63	90·7
40.....	5	78	83	94·1
41.....	2	58	60	96·2
42.....	1	57	58	96·6
43.....	2	38	40	97·7
44.....	–	49	49	–
45–87..	–	182	182	–
Total..	265	1,085	1,350	

The results of our experiments are similar to those reported by other authors for the North Sea, the North Atlantic, and the arctic waters.

Sætersdal (1957) and von Brandt (1957), for example, obtained the same values for the selection factors as we did (3·4) when using the manila cod-end for the Spitsbergen region cod. The same was observed by McCracken during his experiments with the manila cod-end in St. Lawrence Bay. Beverton (1956) gives a selection factor of 3·2 for the cod, when using the sisal cod-end in the North Sea. This factor is not much higher than that obtained by us in the Baltic. McCracken gives the selectivity factor 3·6 for cotton twine. The difference between the selectivity of hemp and manila cod-ends was examined by Boerema

Table 4. Length-frequency distribution of cod (Cotton No. 20/54, mesh size 73.1 mm)

Length, cm	Number of fish in			% in cod-end (smoothed)
	Cover	Cod-end	Cod-end + cover	
6.....	2	–	2	–
7.....	8	–	8	–
8.....	13	2	15	6·8
9.....	52	4	56	10·3
10.....	84	10	94	7·7
11.....	102	6	108	7·1
12.....	121	7	128	5·0
13.....	89	4	93	4·2
14.....	94	3	97	7·1
15.....	98	16	114	8·2
16.....	129	11	140	11·5
17.....	115	17	132	14·8
18.....	98	31	129	21·4
19.....	79	30	109	31·8
20.....	75	59	134	38·7
21.....	80	65	145	45·7
22.....	78	73	151	48·5
23.....	63	70	133	53·9
24.....	62	97	159	64·8
25.....	34	145	179	73·3
26.....	35	125	160	82·8
27.....	18	151	169	85·9
28.....	20	192	212	92·1
29.....	8	221	229	94·6
30.....	11	337	348	97·0
31.....	6	282	288	98·2
32.....	–	375	375	–
33–75..	–	3,213	3,213	–
Total..	1,574	5,546	7,120	

Table 5. Length-frequency distribution of cod (Hemp, mesh size 74.7 mm)

Length, cm	Number of fish in			% in cod-end (smoothed)
	Cover	Cod-end	Cod-end + cover	
5.....	–	–	–	–
6.....	–	–	–	–
7.....	–	–	–	–
8.....	–	–	–	–
9.....	–	–	–	–
10.....	–	–	–	–
11.....	1	–	1	–
12.....	1	–	1	–
13.....	4	–	4	–
14.....	1	–	1	–
15.....	1	–	1	–
16.....	–	–	–	–
17.....	–	–	–	–
18.....	3	–	3	–
19.....	2	–	2	–
20.....	10	1	11	6·9
21.....	15	2	17	9·2
22.....	26	2	28	9·5
23.....	37	4	41	8·3
24.....	34	3	37	9·5
25.....	33	4	37	15·4
26.....	37	14	51	28·8
27.....	31	29	60	47·1
28.....	22	42	64	59·6
29.....	30	56	86	73·8
30.....	11	108	119	83·3
31.....	6	96	102	92·7
32.....	7	100	107	94·7
33.....	3	88	91	95·8
34.....	2	75	77	97·6
35.....	1	93	94	98·7
36.....	–	62	62	–
37–72..	–	387	387	–
Total..	318	1,166	1,484	

(1956). Boerema agrees with us that hemp cod-ends release larger fish than do the manila cod-ends.

Since the net and the shape of the fish are both decisive as to the selectivity, we conducted investigations with regard to length/girth relationship for the purpose of comparing the body shape of the Baltic cod with that of the North Atlantic species. Three hundred cod caught in June in the coastal area of Gdańsk Bay (at a depth of 20–40 m), and 300 fish caught in the open sea (at a depth of 60–80 m) in July were measured. The first sample was composed only of fish which were feeding, while in the second sample there were quite a number of fish still in the spawning stage with empty stomachs.

Measurements were made aboard the research vessel directly after the fish were taken out of the sea. The girth measurements were made by means of a thin loop-shaped tape with a millimetre scale. The girth was measured beyond the operculum just in front of the dorsal fin. We recognized the so-called "natural girth" measured without any pressure on the fish body and the "constricted girth", which was obtained by drawing the tape closely around the body. The pressure used in the latter case was about 1 kg.

A detailed comparison of the results obtained is given in Table 8. The length/girth relationships are as follows:—

	Length/girth relationship	
	Natural girth	Constricted girth
Feeding cod	1·84	2·03
Mixed cod (spawning and feeding cod)	1·94	2·18
Joint average	1·90	2·09

According to Margetts (1956) the relationship of length to the natural girth of a feeding cod caught in August in the North Sea is 1·93 and to the constricted girth 2·06. These values differ only slightly from those obtained by us. It is for this reason that the selection factors of the Baltic cod are similar to those for North Sea cod.

As the length/girth relationship depends upon the state of the gonads and the filling of the stomach of the fish, it seems reasonable to conduct systematical investigations in a yearly cycle for both regions. The

Table 6. Length-frequency distribution of cod (Manila, mesh size 72.1 mm)

Length, cm	Number of fish in			% in cod-end (smoothed)
	Cover	Cod-end	Cod-end + cover	
5.....	–	–	–	–
6.....	–	–	–	–
7.....	–	–	–	–
8.....	–	–	–	–
9.....	–	1	1	–
10.....	1	–	1	–
11.....	–	1	1	–
12.....	–	–	–	–
13.....	7	–	7	–
14.....	5	2	7	–
15.....	20	4	24	–
16.....	21	–	21	–
17.....	58	6	64	–
18.....	100	11	111	10·0
19.....	153	19	172	11·1
20.....	201	29	230	14·7
21.....	246	64	310	18·7
22.....	227	68	295	23·8
23.....	171	66	237	33·0
24.....	118	111	229	45·4
25.....	98	148	246	59·1
26.....	62	137	199	70·1
27.....	40	178	218	77·9
28.....	24	121	145	85·4
29.....	14	149	163	90·4
30.....	9	243	252	94·4
31.....	9	192	201	96·9
32.....	2	193	195	97·8
33.....	2	212	214	99·1
34.....	1	259	260	99·5
35.....	–	414	414	–
36–74..	–	2,837	2,837	–
Total..	1,589	5,465	7,054	

Table 7. Length-frequency distribution of cod (Sisal, mesh size 67.3 mm)

Length, cm	Number of fish in			% in cod-end (smoothed)
	Cover	Cod-end	Cod-end + cover	
5.....	–	–	–	–
6.....	–	–	–	–
7.....	–	1	1	–
8.....	1	1	2	–
9.....	4	2	6	–
10.....	25	11	36	–
11.....	50	7	57	–
12.....	85	6	91	–
13.....	97	10	107	9·1
14.....	110	16	126	11·4
15.....	155	24	179	17·0
16.....	81	27	108	23·9
17.....	86	42	128	30·7
18.....	74	38	112	37·5
19.....	66	55	121	43·2
20.....	74	75	149	48·6
21.....	65	66	131	51·4
22.....	61	71	132	52·8
23.....	44	53	97	55·1
24.....	53	71	124	62·5
25.....	37	117	154	71·6
26.....	23	104	127	81·2
27.....	19	117	136	83·8
28.....	19	97	116	84·8
29.....	22	125	147	87·9
30.....	13	253	266	91·0
31.....	17	226	243	95·6
32.....	3	256	259	96·4
33.....	6	227	233	98·4
34.....	3	332	335	98·6
35.....	3	485	488	99·1
36.....	3	332	335	99·3
37.....	1	331	332	99·5
38.....	–	238	238	–
39–87..	–	2,309	2,309	–
Total..	1,300	6,125	7,425	

anges in the maturity of the gonads and in the feed-g of the fish must be taken into consideration.

Passing on to consider the subject of the minimum esh sizes, it should be borne in mind that according the recommendations of the *ad hoc* Committee ready mentioned, the minimum mesh size and the e limit of the fish should correspond, e.g., the size nit should be similar to the length of the fish at the) % mesh selectivity point. From the results of our re-nt investigations on the selectivity of cod-ends for e purpose of establishing the minimum trawl mesh es, we can form the following formula:—

$$\frac{50\,\%\text{ selection length}}{\text{mesh size}} = \text{selection factor}$$

calculate an adequate size for the trawl mesh in lation to any proposed size limit for the cod.

The appropriate mesh sizes of the cod-end investi-ted by us for cod of a 30 cm size limit assuming a) % selectivity are as follows:—

cotton cod-end No. 40/24 = 79 or 80 mm
cotton cod-end No. 20/54 = 98 mm
hemp cod-end..... = 82 mm
manila cod-end..... = 89 mm
sisal cod-end ..... = 98 mm

It is apparent therefore that the minimum size of trawl meshes for cod in the Baltic should be at least 80 mm.

It should be stressed that the same mesh size is obligatory under the Convention of 1946 in the area of the North Sea, where the size limit of the cod is also 30 cm. On the other hand, an analysis of the mesh size and size limit of the cod which was recently conducted by the *ad hoc* Committee proved that there is no necessity for introducing any changes.

In future it may be useful to consider an eventual differentiation of sizes of the cod-end mesh made of various kinds of materials. It appears from observations that the heavy manila and sisal cod-ends are less

Table 8. Length and girth measurements

15.-17. VI. 1957, Bay of Gdańsk (shallow water, feeding cod)				*3.-5. VII. 1957, Bay of Gdańsk (deep water, feeding + spawning cod)*			
Length of fish	Number of fish	Mean natural girth, cm	Mean constricted girth, cm	Length of fish	Number of fish	Mean natural girth, cm	Mean constricted girth, cm
20	2	10·2	9·5	20	–	–	–
21	2	10·5	9·7	21	1	–	9·0
22	3	11·0	10·0	22	–	–	–
23	7	12·2	11·2	23	–	–	–
24	13	12·9	11·7	24	2	12·5	11·2
25	18	13·3	12·2	25	1	11·5	10·5
26	13	14·3	13·0	26	3	11·8	10·5
27	19	13·9	13·8	27	5	13·9	12·2
28	19	15·2	13·9	28	6	14·4	12·5
29	16	15·9	14·0	29	9	14·2	12·6
30	18	15·6	14·3	30	8	16·1	14·3
31	17	16·9	15·5	31	11	15·3	13·5
32	18	17·6	16·1	32	16	15·9	14·0
33	12	18·1	16·6	33	8	16·3	14·3
34	14	18·4	17·0	34	12	16·7	14·9
35	13	19·1	17·8	35	15	18·0	16·0
36	10	19·1	17·5	36	15	18·7	16·8
37	4	20·6	18·7	37	18	19·0	16·9
38	7	20·7	18·7	38	20	19·2	17·3
39	8	21·5	19·6	39	15	20·2	18·1
40	7	22·0	20·0	40	16	20·7	18·6
41	9	23·2	21·1	41	17	22·2	20·0
42	6	23·7	21·4	42	20	22·2	20·0
43	6	25·1	23·1	43	6	21·7	20·0
44	4	25·1	22·6	44	7	21·6	19·5
45	3	25·3	23·3	45	12	23·8	21·4
46	2	25·0	22·2	46	12	25·0	22·6
47	3	27·6	25·5	47	4	24·6	21·8
48	3	28·0	25·5	48	1	24·5	22·5
49	5	26·9	24·7	49	4	25·4	22·7
50	4	27·3	23·5	50	5	28·8	26·1
52	5	29·0	26·7	51	4	25·8	23·3
58	1	32·0	29·5	52	6	26·5	23·4
60	1	32·5	29·5	53	5	29·2	26·0
65	1	35·0	31·0	55	1	31·0	28·0
68	1	36·0	31·0	56	3	30·3	28·0
70	1	32·5	30·0	57	1	29·5	26·5
85	1	45·0	39·0	59	2	30·5	27·5
Total	296			60	2	32·5	29·5
				63	1	33·0	30·0
				64	1	29·5	27·0
				65	1	32·0	29·0
				67	1	32·0	28·5
				68	1	33·5	30·0
				70	1	33·5	30·5
				78	1	43·0	39·0
				Total	300		

selective than the light cod-ends made of fine cotton or hemp.

The selectivity of cod-ends produced from synthetic twine, which are recently introduced in the Baltic, is still to be examined. The investigations of von Brandt (1957), Margetts (1957), and McCracken (1957) have proved that they are still more selective than the cotton cod-ends. The selectivity of fish by the particular sections of the trawl is still to be investigated more excatly too. The investigations of Borowik (1930) and Beverton (1957) have shown that there may be quite essential differences in this respect.

The initial observaitons conducted by us in this field, by means of a cod-end with a cover divided into two parts by a horizontal partition wall, showed marked differences in the passing of the fish through the upper and lower sections of the cod-end. It was stated in two experimental hauls of this kind that more than 80 % of the fish pass through the upper section and the remainder through the lower one.

The Joint Meeting of ICNAF, ICES, and FAO held in Lisbon in June 1957 pointed to the necessity of further investigations on the selectivity of trawl nets. These investigations should consider all the factors possible, which are decisive as to this selectivity.

Conclusions

1. The selectivity of the cod-end in the case of cod depends upon the quality of the material used, the thickness, construction, and elasticity of the twine. The estimated selectivity factors for the particular cod-ends are presented in Table 1.

2. The establishment of a minimum mesh size of cod trawl nets of 80 mm may be proposed on the basis of the results obtained during our investigations in the Baltic and by comparison with those obtained in the North Sea and the North Atlantic by other authors.

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Joint Meeting of the Baltic-Belt Seas Committee and the Salmon and Trout Committee to Discuss Salmon Problems of the Baltic

The meeting was held on 1. October 1957 at Bergen nd the following papers were read and discussed:—

1. G. Alm: "Note regarding the salmon fisheries in ie Baltic in recent years".
2. B. Carlin: "Results of salmon smolt tagging in ie Baltic area".
3. F. Chrzan: "The principles of protection of salonid fish in the Baltic".

Participants:—

enmark:
a. J. C. Jensen
. Larsen

inland:
. Halme
. Sjöblom

ermany:
. Kändler

eland:
. E. J. Went

orway:
. Rosseland

oland:
. Cieglewicz
. Chrzan
. Zarnecki

Scotland:
K. A. Pyefinch

Sweden:
G. Alm
B. Carlin
J. Hult
A. Lindquist
A. Lindroth
G. Otterlind
S. Runnström

U. S. S. R.:
T. Dementjeva
N. Dmitriev
I. Lagunov
G. Nikolsky

Professor G. Nikolsky was elected Chairman for the eeting and Dr. Aa. J. C. Jensen acted as Rapporteur.

Summary of the Discussions

The biological basis of the salmon and sea trout sheries of the Baltic was discussed and it was agreed at the stocks and fisheries would profit by the inoduction of protective measures. Various possible ethods were discussed.

Dr. Alm reviewed recent changes in the yield of the lmon fishery. The proportion of small salmon in the tches has decreased during the period 1956/57. bout 60 % of the stock of salmon in the Baltic were derived from Swedish rivers, about 40 % from Finland and the USSR with a small part from Poland. Sweden takes about 25 % of the total catch and Denmark more than half.

In his paper, Carlin drew attention to the fact that in a few years, natural propagation in Swedish rivers will be almost non-existent. This will have serious consequences for the salmon fisheries of the Baltic which will then depend to a great extent on the liberation of salmon smolts by Sweden. The annual output of smolts in Sweden is now 300,000 but in ten years time the number ought to be about 2,000,000 to compensate for the loss of natural spawning potential.

Dr. Alm mentioned that at present the rearing of smolts was mostly financed by hydro-electric plants.

According to Carlin, large-scale Swedish taggings of smolts have shown that the value of the catch of salmon originating from the liberation of smolts is higher than the cost of producing them. Most of the catch is taken in the central Baltic by countries other than Sweden. In 1956/57 Danish fishermen made almost two-thirds of the total recaptures, German and Swedish fishermen about one-sixth each, and Poland, Finland, and the USSR very few. These returns correspond very well with the ratio of the commercial catches in the Baltic. From these facts it is clear that the propagation of smolts is not economic for Sweden (Point 5 of the recommendations).

Carlin has estimated the annual mortality in the sea and further, that the natural mortality in the first year must be about 90 %. In the second and third year it is very much less, about 17 and 15 % respectively, of the stock at the beginning of the year, whereas the fishing mortality is 34 and 48 %. In these years the stock is also reduced by migration, and after three years very little is left.

Alm in his paper also gave evidence of how the introduction of a high size limit for salmon would benefit the fishery and it was unanimously agreed that it would pay to have an international size limit.

Chrzan in his paper argued in favour of the introduction of the same size limit for salmon and sea trout, because some fishermen cannot distinguish between them. He wished to have the size limit fixed at 55 cm, which is nearly the practical commercial size

limit of the Polish fishery. During the discussions, other countries stressed the point of view that a size limit higher than 55 cm would be of greater value to the fishery, and that the size limit for salmon ought to be higher than that for the sea trout (Points 1 and 3 of the recommendations). It was felt that investigations into the migrations of sea trout should be carried out in order to decide if an international size limit for this fish should be introduced.

Alm in his paper gave an example of how unfavourable weather conditions in the winter months of 1955 had curtailed the Swedish fishery in that year with a consequential reduction in the yield. This had the effect of increasing the yield of fish during their third winter in the sea in the following year, which seems to indicate that a close season in winter would be useful. During the discussion, however, it was stressed that a close time in winter would be a handicap for fishermen of those countries where fishing is restricted to this season, since those fishermen would have little chance of reaping the benefit resulting from such a close season because they would not fish at other times of the year.

Alm and Chrzan stressed the necessity of an international regulation of the size of hooks used, with the object of increasing the size of the total catch (Point 4 of the recommendations). The importance of a minimum mesh for salmon nets was also discussed (Point 2 of the recommendations).

Recommendations

After discussion of the relevant papers and other available information the following recommendations were made:—

1. That a minimum size limit for salmon of at least 55 cm should be introduced internationally.
2. That a minimum mesh for salmon nets and a minimum size of hooks corresponding to the minimum length of the salmon should be introduced internationally.
3. That every country should be asked to introduce size limits for sea trout as high as possible and to undertake the rearing of sea trout.
4. That a close season for the salmon fishing for the protection of the stock and to prevent overfishing, should be established internationally.
5. That, as the rearing of salmon on a large scale is of vital importance to the continuation of the salmon fishery in the Baltic, arrangements should be made for discussions as to the possibility of financial contributions from those countries not undertaking this work to those so engaged.

The Baltic-Belt Seas Committee and the Salmon and Trout Committee therefore ask the Council to communicate these recommendations to the governments concerned.

Aa. J. C. Jensen

10.

Principles for the Protection of Salmonid Fish in the Baltic

By

F. Chrzan

The yield of the salmon fishery in the Baltic has varied in a characteristic manner during the past ten years. According to Dr. Alm, the catches in the period between the wars were rather poor, the mean annual landings amounting to about 950 tons. After the second World War, up to 1950, a considerable increase was observed, the mean being about 3,700 tons. In the following years the catches decreased to 1,600 tons in 1953, and this was followed by a slight increase.

It seems that the rise after the second World War was caused by the accumulation of fish due to the reduced fishing intensity during the war period. Protective measures which have been introduced no doubt influenced the number of salmon.

After the war, owing to the appearance of rich broods, fishermen interested in other kinds of fisheries took up salmon fishing. A new technique of fishing was developed. The fishermen began to use larger and more powerful vessels than they had used in the pre-war years, and the fishing regions were not limited solely to the nearest coastal waters but embraced almost the entire Baltic. The fishery in the southern Baltic, which was most profitable in November, December, and in the spring months of April and May, was now extended to the greater part of the year, but, as far as the whole of the Baltic is concerned, fishing operations were not carried out during the summer months, when the salmon most likely disappear into the deeper water and thus escape the fishing gear.

Apart from more powerful fishing vessels, new or modernized fishing gears were used. Formerly the salmon were caught by means of drift-nets during the spring and by the so-called "standing lines" with one hook during the autumn/winter period. The Polish fishermen, following the example of the fishermen of other Baltic countries, began to use the so-called drift long-lines, the length of which at times amounted to as much as 20 km, and the number of hooks used on such lines might reach a thousand. During the first years the same type of hook was used on the drift long-lines, as was formerly used for standing lines.

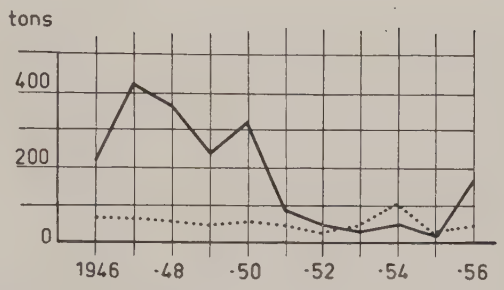


Figure 1. Salmon and sea trout in Polish catches.
——— *Salmo salar*
. . . . . *Salmo trutta*

They were about 10 cm long and the distance from the shank to the point was 26 mm, but since 1950, smaller hooks have been introduced and because of this the salmon which are not quite fully grown are caught.

Salmo salar is the most important of the salmonid species found in the Baltic catches, and they appear to be caught at some distance from the coast. Apart from salmon, Polish fishermen catch a considerable number of sea trout (*Salmo trutta*), and unlike the salmon, this species is caught near the coast and usually in the neighbourhood of river estuaries.

Polish catches of salmon and trout are subject to marked fluctuations which are not entirely dependent on the number of fish appearing in the southern Baltic. In 1951, for example, many Polish fishermen changed over from salmon fishing to fishing for cod, which appeared abundantly in Gdańsk Bay.

Figure 1 shows the results of the Polish salmon fishery in the years 1946—1956 which amounted to about 300 tons annually, whereas the catches of trout amounted to 60 tons. After 1950 Polish catches of salmon decreased very much and in 1955, Polish fishermen caught the smallest amounts of salmon (17 tons) and trout (26 tons). The maximum catch of trout which was about 102 tons was taken in 1954.

The rapid development of the salmon fisheries in the Baltic up to 1950, followed by the decrease in the catches which was observed both in the Polish

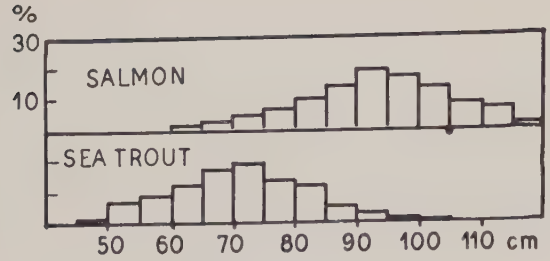


Figure 2. Length composition of spawning salmon and sea trout.

fisheries and in those of other Baltic countries, suggests that unrestricted exploitation may lead to a failure in the fisheries. The sturgeon is a good example of this. This fish appeared in large quantities in European waters 80 to 100 years ago, whereas at present it is very scarce. This fact should act as a warning, and, at the same time, encourage the introduction of reasonable protective measures.

Salmon and trout are noted for their rather weak biotic potential. This is due firstly to the scarcity of eggs produced, and secondly to the fact that these species mature very late. According to our observations about 2,000 eggs are produced per kg of body weight of female sea trout, while the relative number for salmon is 1,600 eggs per kg. In comparison with the herring, cod, or flatfish, producing tens or even hundreds of thousands of eggs per kg of body weight, the fertility of the salmonid fish must obviously be very poor. Another important factor is the late sexual maturity. Species exploited in the Baltic, such as the cod and herring mature at the end of their third year of life, but the majority of salmon only start their migration from the rivers to the sea at the end of their third year. It is true that a considerable number of the salmon migrate to the sea after their second year but there are individuals which remain in the river for even five years. The trout bred in Polish rivers usually migrate to the sea after their second year of life. The salmon migrate to the spawning grounds for the first time after three, four or even five years in the sea. The trout enter the rivers a little earlier than the salmon, sometimes after two years but mostly after three years of life in the sea.

Thus, the trout generally reach maturity earlier than the salmon. Both species mature late, after a period which is twice as long as that of most other important commercial species in the Baltic.

After becoming sexually mature for the first time cod, herring or flatfish spawn annually, whereas scale readings show that few salmon and trout survive to spawn for a second time. Individuals spawning three times have never been identified.

The numerical composition of the salmonid fish stock is influenced by the system of life in two environments — the fresh water and the sea. Conditions of life for migratory fish are made difficult by the building of dams on rivers and the discharge of various waste products. These are some of the reasons for the total disappearance of the salmonid fish. The spawning and feeding grounds in which the new broods are hatched may be cut off by the dams, and turbines installed at the dams may destroy large numbers of smolts migrating to the sea. Many examples illustrating the influence of pollution of river waters by waste products on the stock of salmonid fish could be mentioned, and there is no doubt that industrial development and the pollution of the river waters have increased to a great extent, the mortality in these fish.

Consequently the maintenance of the stocks of salmon and trout at a high level necessitates the adoption of very special measures as regards fishing. In the case of migratory salmonids, protective measures both in fresh water and in the sea are consequently necessary.

Since the older age-groups are of greater commercial value than the younger ones, protection of the juvenile or immature individuals is absolutely necessary.

When protecting measures for a species of fish are introduced the size of the fish at first maturity is often considered, in order to secure participation in the spawning. Vulnerable species such as salmon and trout should be better protected than the majority of other commercial fish.

Figure 2 shows the length composition of the spawning salmon and trout stock. The length of the spawning salmon has been estimated from scales with spawning marks. The length of the trout has been calculated on the basis of measurements of fish migrating for the first time to the spawning grounds in various Polish rivers. It appears from Figure 2 that the majority of salmon spawn after having reached a length of 90 cm, while trout are in most cases mature at a length of 70 cm. Considering therefore, the vulnerability of the salmonid species, the minimal protective size for the salmon should be 90 cm and for the trout 70 cm. If such protective measures were introduced, the majority of individuals would have a chance of participating in the spawning, but the acceptance of such large protective sizes might lead to a kind of revolution in the salmon fisheries and, would of course, provoke opposition from fishermen.

Lengths of 60 cm for the salmon and 50 cm for the sea trout seem to be acceptable as the minimum sizes for these species, or, because of this great similarity, it might be advisable to adopt 55 cm as the minimum size for both species. The above mentioned minimum

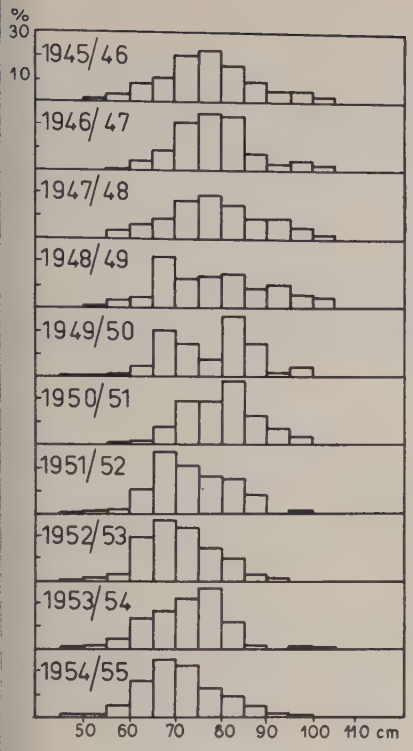


Figure 3.
Length composition of sea trout (according to the weight of each length group).

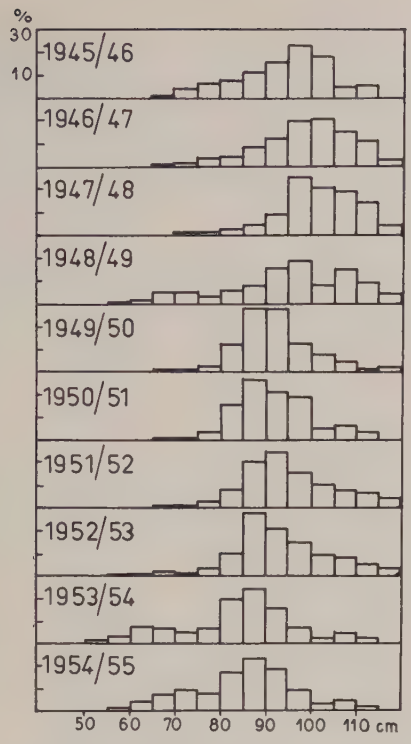


Figure 4.
Length composition of salmon caught by hooks (according to the weight of each length group).

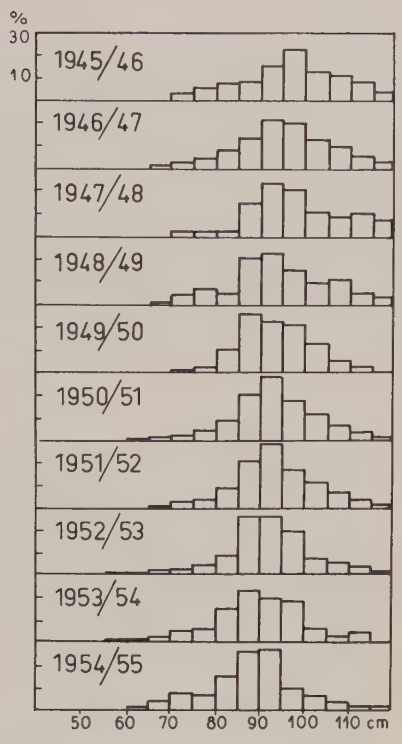


Figure 5.
Length composition of salmon caught by drifts-nets (according to the weight of each length group).

sizes for fish may be considered as a compromise, and their adoption would certainly be a step forward in attempting to keep the stocks of salmon and trout in the entire Baltic under control.

Figures 3, 4, and 5 show the weight of the different length groups of the salmon caught by Polish fishermen during the period 1945 to 1955. These figures explain the losses which the fisheries would suffer in the initial period after the introduction of the proposed minimum sizes. Figure 3 shows the percentage weight of the different length groups of the trout caught near the Polish coast. The quantity of fish under 50 cm in length does not exceed 0.3 %, while the fish under 55 cm in length amounts to 1.2 %. Figure 4 indicates that the catches of small salmon by hooks were most abundant during the 1953/54 season. In that year the yield of fish under 60 cm in length amounted to 3.8 % of the total landings of fish caught by hooks. In other years the salmon of smaller dimensions were much less numerous.

Figure 5 shows the catches taken by means of drift-nets, and from this it will be seen that the catches of salmon of less than 60 cm in length constituted less than 0.5 % of the quantity of salmon caught by means of drift-nets.

These facts indicate that after the introduction of the proposed minimum sizes the total landings would only be slightly reduced in the initial period. On the other hand, the fact that a larger number of individuals will be left in the sea will not only augment their chance of participating in spawning, but there will also be a better yield owing to their natural increase in weight during the season.

Figures 4 and 5 show that a larger number of salmon of small dimensions are caught by means of hooks than by means of drift-nets, and it appears that the number of very small salmon in the catches has increased in recent years, owing to the use of small hooks. The size, obviously depends on the size of the hooks used. It can be concluded therefore, that in order to ensure the degree of protection proposed above, it will be necessary to fix a minimum size of hooks for the drifting gear. Investigations have shown that fish under 60 cm in length are seldom caught on hooks measuring 19—20 mm from the shank to the point, therefore, this size should be adopted as the minimum for hooks. Figure 5 shows that most of the salmon taken by drift-nets are fully grown.

Individuals under 60 cm in length are caught only in very small numbers, and until recently such in-

dividuals have not been found in the Polish catches. The yield of salmon under 60 cm in length did not amount to more than 0.5 % of the total landings. The drift-nets, which Polish fishermen use, have meshes measuring 80, 85, 90, and 95 mm from knot to knot, and, since meshes of this size seldom retain fish under 60 cm in length the minimum mesh size for salmon drift-nets should be put at 80 or 85 mm.

In spite of introducing the proposed minimum size for the salmon hooks it should be borne in mind that if a large number of small salmon appear, or if there should be a lack of natural food such as herrings or sprats, the undersized salmon will still be caught on the legal size hooks.

Investigations have shown that the greatest number of undersized salmon approach the Polish coasts at the end of January or the beginning of February, and because of this it would seem appropriate to introduce a close season for salmon from 15. January to 15. February, or for the whole of January, each year.

Reference

Alm, G., 1954. "Laxfisket och laxbeståndet i Östersjöområdet under senare år." Svenska Vattenkraftfören., *441*: 5.

11.

Notes Regarding the Salmon Fishery in the Baltic during Recent Years

By

Gunnar Alm

The yield of the salmon fisheries

The very small salmon catches in the Baltic in 1955 were followed by an increase in the year 1956. This was the case in all countries bordering the Baltic for which statistics are available (Table 1).

Table 1. Salmon catches in tons in the Baltic

Year	Sweden	Finland	Denmark	W. Germany	Poland	Total
1952....	790	383	1,350	144	43	2,706
1953....	422	350	753	75	24	1,624
1954....	484	abt. 400	962	116	43	2,005
1955....	296	abt. 200	609	158	17	1,280
1956....	671	abt. 300	961	285	156	2,373

In Sweden and Poland especially this increase has been very substantial. Assuming that the total salmon catch taken by Finland is about 300 tons, the total yield of the Baltic salmon fisheries in 1956 would have amounted to about 2,300 tons, a total increase of about 1000 tons over that of 1955.

The very poor Swedish catches in 1955 were partly the result of climatic conditions which prevented fishing during the winter months in the Baltic proper. Only about 60 % of the Swedish salmon catch were taken there in 1955, as in 1952, whereas in other years 75 to 77 % were taken (Table 2). The figures for the Gulf of Bothnia include catches in the open sea, together with those on the coasts near the mouths of the rivers.

In Table 2 figures from the Baltic rivers of Sweden are also given. Here also an increase of the yield occurred in 1956, compared with 1955, but not so pronounced as for the fisheries in the open sea.

Table 2. Swedish salmon catches in different parts of the Baltic

Year	Baltic Proper		Gulf of Bothnia		Baltic rivers
	Tons	%	Tons	%	Tons
1952.....	460	58	330	42	226
1953.....	273	64	149	36	174
1954.....	364	75	120	25	130
1955.....	179	61	117	39	110
1956.....	528	79	143	21	140

In 1957 catches in Swedish waters again decreased. During the first six months of that year the yields from the Gothland and Blekinge fisheries amounted to about 33 and 73 tons, respectively, compared with 45 and 154 tons respectively, in 1956.

Table 3. Salmon catches (weight) in different months as percentages of the total annual catch

Month	W. Germany		Denmark		Poland		Blekinge		Gothland	
	1951–55	1956	1951–55	1956	1951–55	1956	1951–55	1956	1951–55	1956
I....	21	7	14	7	7	1	2	–	7	1
II...	15	1	11	3	4	–	1	–	4	1
III..	13	10	8	–	7	–	4	–	3	–
IV ..	9	10	12	10	30	20	27	18	7	3
V ...	6	5	7	18	22	51	24	42	25	24
VI ..	1	1	2	5	–	4	5	7	10	6
VII .	–	–	1	–	–	–	1	–	1	–
VIII	–	–	–	–	–	–	4	4	–	–
IX ..	–	–	1	2	–	–	12	16	3	23
X ...	–	7	6	13	2	–	10	4	15	20
XI ..	12	26	19	22	15	6	6	6	15	17
XII .	24	33	19	20	13	18	4	3	10	5

In Table 3 the catches for the different months as percentages of the total catch in 1956 and the means for the period 1951 to 1955 are given. During the first months of 1956 the catches were smaller than usual. German catches were particularly good in the last months of the year. In the other countries the catches in May were fairly good, and the Blekinge and Gothland fisheries gave good yields also in September. The interruption in the fishery during summer was thus shorter in 1956 than in the preceding years.

Details of the catches per unit of effort for the net fisheries in spring are given in Table 4. The information was obtained from a number of fishermen of Blekinge.

Table 4.

	Number of nets × lifts	Number of salmon per 100 lifts
1953...	4,432	4·4
1954...	4,200	4·5
1955...	3,702	6·6
1956...	5,219	12·9
1957...	6,094	9·8

In spite of the increase in fishing intensity the catches in 1957 were smaller than those in 1956, but much larger than those of the preceding years. A number of fishermen operating with hooks also gave information which shows that the catch per 1,000 hooks was 5.1 salmon in 1956. The figure for 1955 was 5.0 salmon.

The size of the salmon

In the Swedish winter fishing season of 1954/55 salmon belonging to size-group IV (up to 3 kg) were rather common in the Baltic. From Table 5 it will be seen that in 1954 approximately 50 % of the fish caught by the Gothland and Blekinge fishermen

Table 5. Percentage of different size-groups (by number) in different years

Year	Gothland					Blekinge[3])				
	Number caught	Size-groups[1]) (%) I	II	III	IV	Number caught	Size-groups[1]) (%) I	II	III	IV
1953..	14,494	18	19	25	38	882	31	25	19	24
1954..	29,511	8	13	31	48	1,104	10	16	27	47
1955a[2])	6,371	11	12	38	39	4,392	20	23	43	14
1955b	3,063	23	40	28	9	3,029	38	33	21	13
1955..	9,434	16	21	34	29	7,421	27	27	34	12
1956a.	7,380	31	20	46	3	17,875	25	20	54	2
1956b	16,810	10	24	56	10	12,144	13	35	43	9
1956..	24,190	16	23	53	8	30,019	20	26	50	4
1957a.	7,415	7	9	77	7	5,265	9	16	73	2

[1]) I = 8 kg and more, II = 6–8 kg, III = 3–6 kg, IV = up to 3 kg.
[2]) a = Jan./June, b = July/Dec.
[3]) In some years only a part of the total catch.

weighed less than 3 kg. In the autumn of 1955 such salmon were scarce as they were also in 1956 and in the spring of 1957. Salmon belonging to size-group III (3–6 kg) were, however, very common in 1956 and still more so in 1957 when about 75 % of the fish caught belonged to this group. This distribution of the size-groups was quite obvious, both in the Gothland and the Blekinge fisheries.

In former years salmon belonging to the smallest size-group were mostly caught by Gothland fishermen in the first and last months of the year, but during spring and early autumn by the Blekinge fishermen. This difference between the Gothland and Blekinge fisheries was also noticed in 1956, with a preponderance, however, for the latter part of the year (Table 6).

Table 6. Percentage by weight of the total annual catch of size-group IV in different months

Month	Gothland		Blekinge	
	1951–55	1956	1953–55	1956
I.....	15	1	1	–
II.....	12	–	–	–
III.....	12	–	–	–
IV.....	5	7	20	10
V.....	2	6	12	13
VI.....	–	1	4	1
VII.....	–	–	–	–
VIII.....	–	–	22	16
IX.....	1	6	17	34
X.....	10	11	13	5
XI.....	23	48	10	16
XII.....	21	20	1	5

Table 7 shows the catches of salmon belonging to size-group IV as percentages of the total catch taken during the months in which small salmon are especially numerous. In previous years about 50 % or

Table 7. Catches, weight, and numbers of size-group IV as percentages of the total monthly catches

Month	Gothland				Month	Blekinge			
	Weight		Number			Weight		Number	
	1951–55	1956	1951–55	1956		1953–55	1956	1953–55	1956
I.....	19	2	42	6	IV....	6	1	15	2
II.....	23	–	49	–	V.....	4	1	12	2
III.....	24	15	48	33	VIII..	36	4	66	13
X.....	7	2	19	4	IX....	31	3	62	8
XI.....	19	9	39	17	X	8	3	26	7
XII	24	13	48	24	XI....	5	4	13	8

more of all salmon caught in certain months belonged to this group. In 1956, however, the proportion was much smaller, amounting to 33 % in Gothland (March) and only 13 % in Blekinge (August).

12.

Results of Salmon Smolt Tagging in the Baltic Area

By

Börje Carlin

The conservation of salmon in rivers that are being used for hydroelectric power production is a very serious problem in Sweden. Several of Sweden's most important salmon rivers are obstructed by dams near their mouths and the spawning grounds have been more or less completely destroyed in one river after another. In perhaps less than twenty years we shall have no natural reproduction of salmon at all, or practically none, if it is possible to save one or two rivers. In this situation fish passes will be useless. Liberation of salmon fry or fingerlings may be a way for using such parts of the rivers where conditions have not been changed but it is not possible to substitute for the spawning areas destroyed in this way. That means that if we are to replace the lost natural reproduction, we must do this without the help of the rivers and without interfering with whatever capacity of producing salmon smolts they still may retain. As far as we can see now, the only way to do this is by rearing the salmon artificially up to the smolt stage.

When we decided to follow this way a few years ago, we had no proof at all that it was possible, but we had to do something, and the rearing of smolts seemed at least less impossible than other methods. During the last few years several hatcheries have been built or rebuilt for production of smolts and others are still under construction. The annual output in Sweden of reared smolts today is about 300,000, but in ten years the demand is expected to be about two million smolts annually. We must be prepared to meet this demand.

As soon as we could get the necessary reared smolts, we started tagging experiments in order to find out, in the first place, if it is possible to maintain a salmon stock at normal level by only releasing artificially reared smolts, and in the second place, if this can be economically sound, that is whether the value of the catch based on reared smolts is sufficiently high in relation to the expense involved in rearing the smolts.

Since 1950, we have tagged about 275,000 salmon

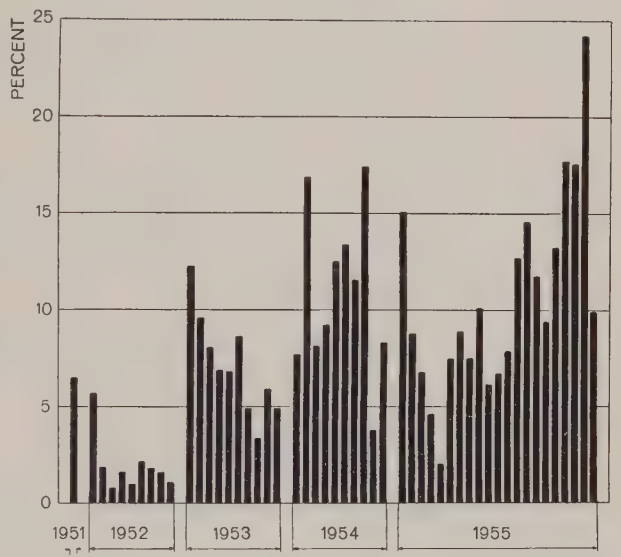


Figure 1. Recaptures as adult salmon (%) of the number of smolts released from all the tagging experiments in the spring. Each column represents a separate tagging experiment.

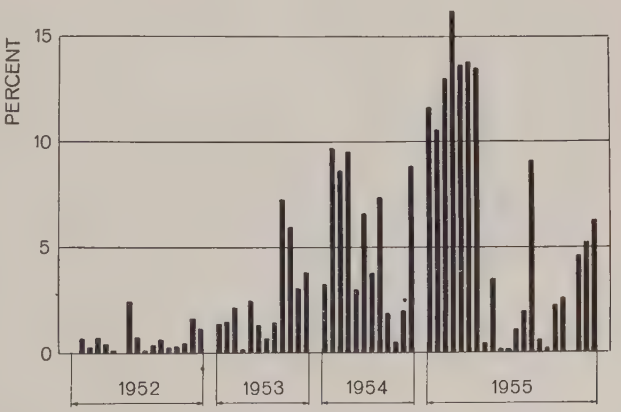
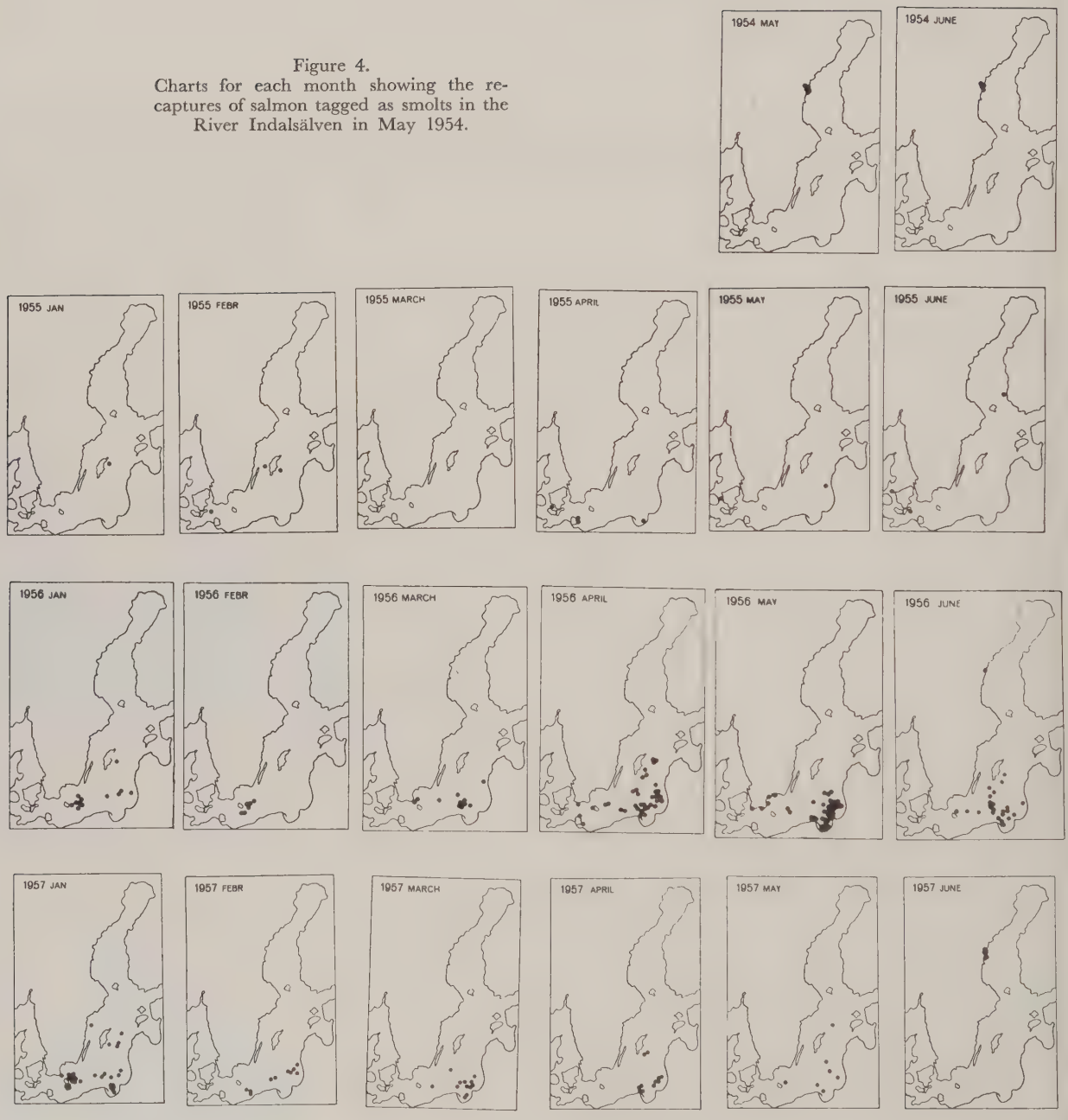


Figure 2. Recaptures from tagging experiments made later in the year than mid-June.

Figure 4.
Charts for each month showing the recaptures of salmon tagged as smolts in the River Indalsälven in May 1954.



1954 JULY

1954 AUG

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1954 NOV

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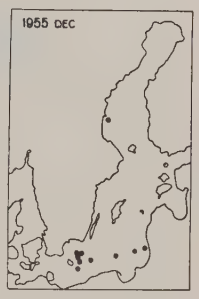
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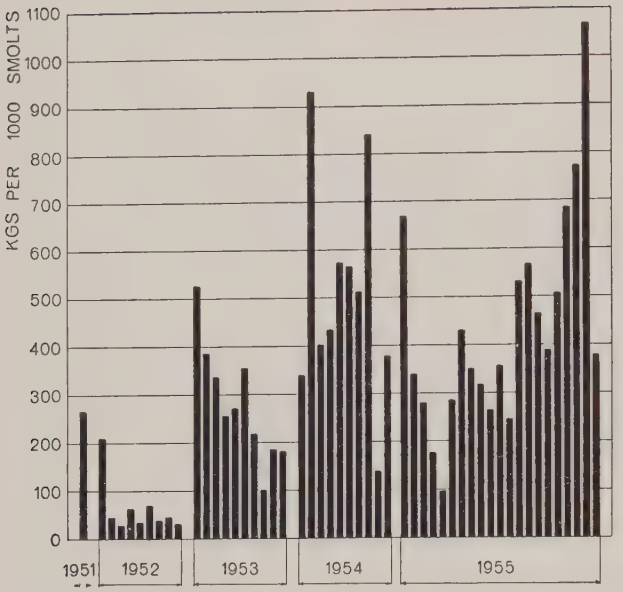

Figure 3. Recaptures from tagging experiments in the spring expressed in kilogrammes of salmon caught per 1000 released smolts.

smolts in the Baltic area. The number of adult salmon recaptured from these tagging experiments up to the end of September 1957, was about 6,400 (15,000)[1]. As most of the tagging was done only recently, the final number of recaptures will be much higher. The total weight was about 22,000 kr (56,000)[1].

The different tagging experiments have given very different results, as can be seen from Figures 1 and 2. The differences in the returns from different batches of tagged smolts have sometimes been considerable. This can give us valuable information as to the usefulness of the methods for rearing and releasing the smolts that have been tested.

So far the proportion of returns from all tagging experiments in the spring of 1954 was 10.1 % (10.4 %)[1], and this figure will probably increase somewhat. The figures for the 1955 tagging experiments may even be higher still (11.6 %)[1]. From a practical point of view it is not the number, but the total weight of the recaptured salmon that is important. Figure 3 shows how many kilogrammes we have got from 1000 smolts in different tagging experiments. From all taggings done in the spring of 1954, we have now obtained 470 kg (488 kg)[1] per 1000 smolts. We can definitely say that the value of 470 kg of salmon is higher than the cost of producing 1000 smolts.

From the tagging experiments we get information

[1] Since this paper was presented to the Symposium the number of recaptures has increased considerably and the corresponding figures referring to recaptures reported up to the end of May 1959 are given in parentheses. The diagrams have been corrected up to October 1958.

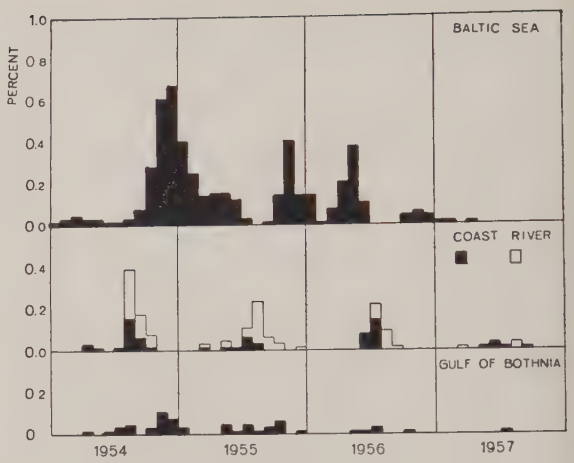

Figure 5. Monthly distribution of recaptures from salmon tagged as smolts in the spring of 1953.

about the sea life of the salmon and of the salmon fishing in the Baltic. In Figure 4, a series of charts for each month show the places of recapture of salmon, released as smolts in the river Indalsälven in May 1954. Most of the salmon are caught on the feeding grounds in the Baltic proper, where all countries around the Baltic participate in the fishing. Others are taken in the rivers, or on the coast near their parent rivers, when they return to spawn. We also have a third group of fish taken in the Gulf of Bothnia further from their parent rivers. This third group may consist both of feeding fish and of fish on their way to spawn. We still know very little about the importance of the Gulf of Bothnia as a feeding ground for salmon, but the majority of salmon from the northern Swedish rivers grow up in the main basin of the Baltic.

Figure 5 shows how the recaptures of salmon tagged in the spring of 1953 were distributed among the different groups in the different seasons. Salmon fishing in the Baltic is operated mainly in winter, and most of the salmon are taken during the second and third winters in the sea. On the other hand, fishing in the rivers and on the coast is carried out mostly during the summer. From the recaptures of tagged salmon, we get the impression, that the migrating salmon leave the feeding grounds rather late in spring and travel rapidly towards the river, but this may be wrong. Nevertheless, very few salmon are taken on their way between the southern and central Baltic and the coast near their rivers of origin. There is only one, more or less continuous, run of salmon in salmon rivers on the Baltic, as the different age-groups are returning about the same time.

Within this general pattern, there are variations from year to year as can be seen in Figure 6. This

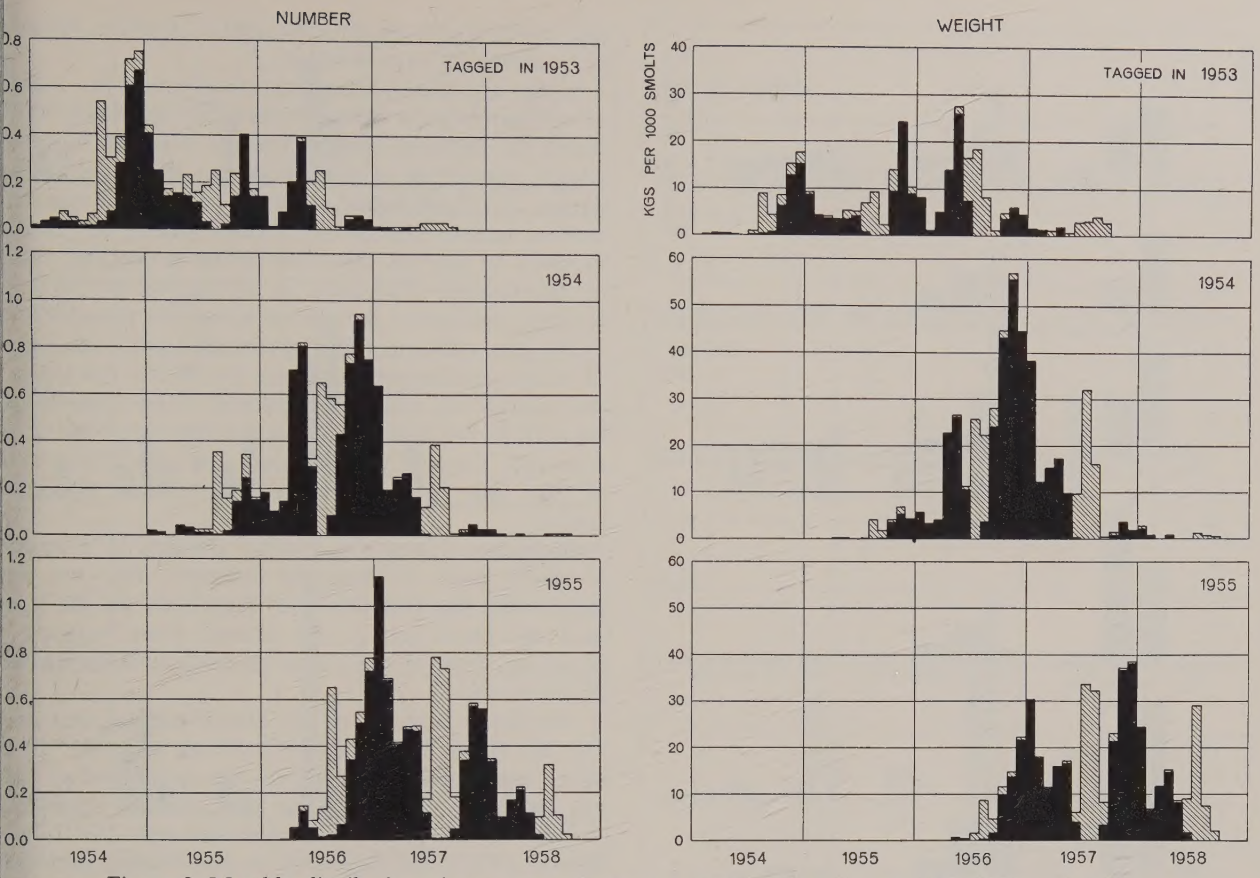

Figure 6. Monthly distribution of recaptures of salmon tagged in the spring of 1953, 1954, and 1955 (Black columns = catches in the Baltic proper).

gure represents the catches for each month in the altic proper for fish tagged in the springs of 1953, 954, and 1955 respectively. The catches, as far as the umbers of fish are concerned appear generally to be little higher in the second winter than in the third, nd the peak occurs in the middle of the winter. owever, in the severe winter of 1955/1956, ice conitions hindered fishing during the winter months. nus, few salmon were caught from December to larch, but more than usual from April to June. As result, considerably more fish from the 1953 yearass were taken in their third winter, and this is still ore evident in the diagram for the weight of the tches (cf. Fig. 6). In this case, we had a natural periment, the results of which indicate the usefulss of a close season in the winter.

The same thing is shown in a more generalized rm in Figure 7. Most of the fish were taken in the altic. A smaller number of fish were captured on the ast and in the rivers, which is the normal way of lmon fishing in regions other than the Baltic. In the ast and river catches there were more pronounced variations in the proportions of the age-groups in the different year-classes. This may be partly due to varying conditions in the sea, but it is probably caused, to a great extent, by differences in the tagged fish. It seems that under the present conditions of the Baltic fishery, most salmon normally return during their third summer. In those cases, however, when a higher proportion of salmon have returned during the second summer, that is as grilse, the explanation has been that the released smolts were larger than normal.

The distribution of the catches among fishermen from different nations is shown in Figure 8. The Swedish catch in the Baltic Sea, as percentage of tagged fish, has slightly decreased during the last few years. On the other hand, the proportion taken by Danish fishermen has increased very considerably. The Danish catch was only a little more than the Swedish a few years ago, but now it is nearly four times as much. The German catches have also increased very much, and they are now of the same magnitude as the Swedish. The Polish salmon fishery is comparatively small. There is very little Finnish

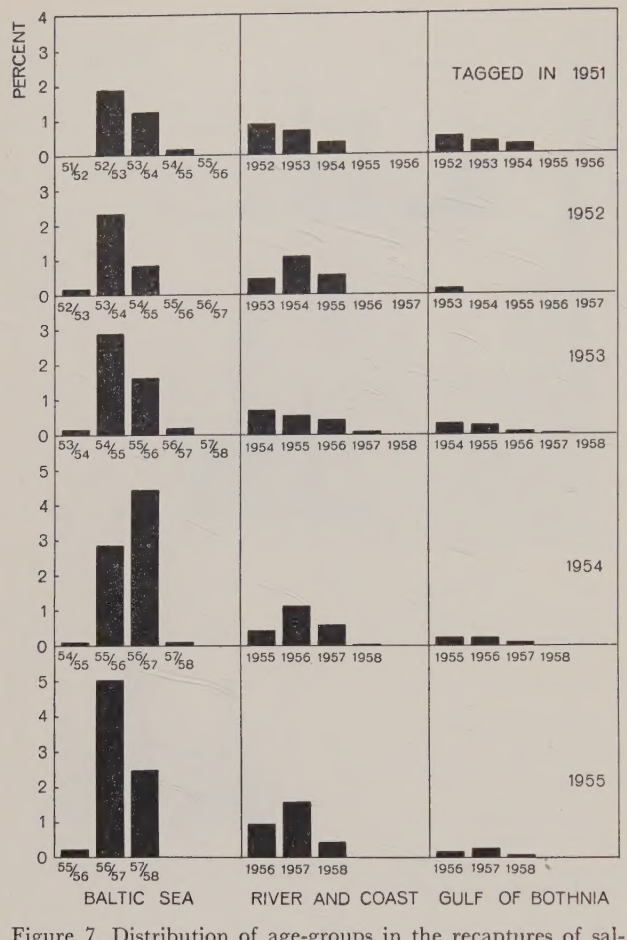

Figure 7. Distribution of age-groups in the recaptures of salmon tagged in the springs of 1951 to 1955.

salmon fishing in the Baltic proper, and the salmon stocks from Swedish rivers seem to be of little importance to the salmon fishery on the Finnish coast. We have obtained only a few tags from the USSR and they were mostly from tagging experiments with kelts.

Judging from the results of our tagging experiments, we can now be fairly certain, that it is both possible and economically feasible to maintain the salmon stock in the Baltic by artificial rearing of salmon alone. We are however, not so sure that it is equally worth while from a purely national economic point of view, since less than half of the salmon we produce are taken by our own fishermen.

The tagging experiments also give information about the biology of the salmon and the interaction between the salmon stock and salmon fishing. But we have no general picture of what happens to the population as a whole. It is not possible to obtain this information from smolt tagging alone. We may still however, try to get some sort of picture, although very uncertain and sketchy.

There are mainly three factors affecting the number of salmon from a certain year-class surviving in the Baltic at different times. One is natural mortality, which apparently to a great extent is caused by predation. A physiological mortality from old age is of no importance before the salmon leave the feeding grounds in the sea. Another factor is the loss caused by the fishing. The third is the migration from the feeding grounds to the parent rivers for spawning.

We can estimate fairly accurately from the figures of recaptured tagged fish from the Baltic the losses to the population caused by fishing. These figures may be a little too low because some tags are lost or not reported. Tagging may perhaps also affect the vitality of the fish. Anyway these figures are reasonably correct.

Escapement from the feeding grounds by migration is much more difficult to estimate. But we have figures for the catch in the rivers and on the coast, and we have made calculations, from tagging of ascending fish, of the ratios of catch and escapement in the rivers.

We know nothing at all about natural mortality. On the other hand, if we have an estimate of the other two factors, the rest may be considered as natural mortality. Further, we can assume that there should be no great difference between the relative figures of natural mortality in the second and third year. We know also that very little of the orginal population remains as maiden fish in the Baltic after three years.

In this way, we get a picture as shown in Figure 4. In the first year mortality has been assumed to be 90 %. The stock is very slightly affected by fishing during this year. About 1% leaves the feeding grounds after one year, but that is 10 % of what is left at that time. This figure is even more approximate than the others, as some grilse may not have grown up in the main basin of the Baltic.

During the second year, natural mortality has been estimated at 1.5 % and the catch at 3 % of the original stock, which is the same as 17 % and 34 % respectively, of the number of fish at the beginning of the year. We can estimate the escapement by migration after two years at 1 %, which this time means 23 % of what is left at the end of the second year. During the third year the loss by natural mortality is estimated at 0.5 % and that by fishing at 1.6 %. This means 15 and 48 %, respectively, of the number of fish present at the beginning of the third year. At the end of the third year another 1 % leaves the feeding grounds, and very little is left.

At a first glance, it would seem quite out of pro-

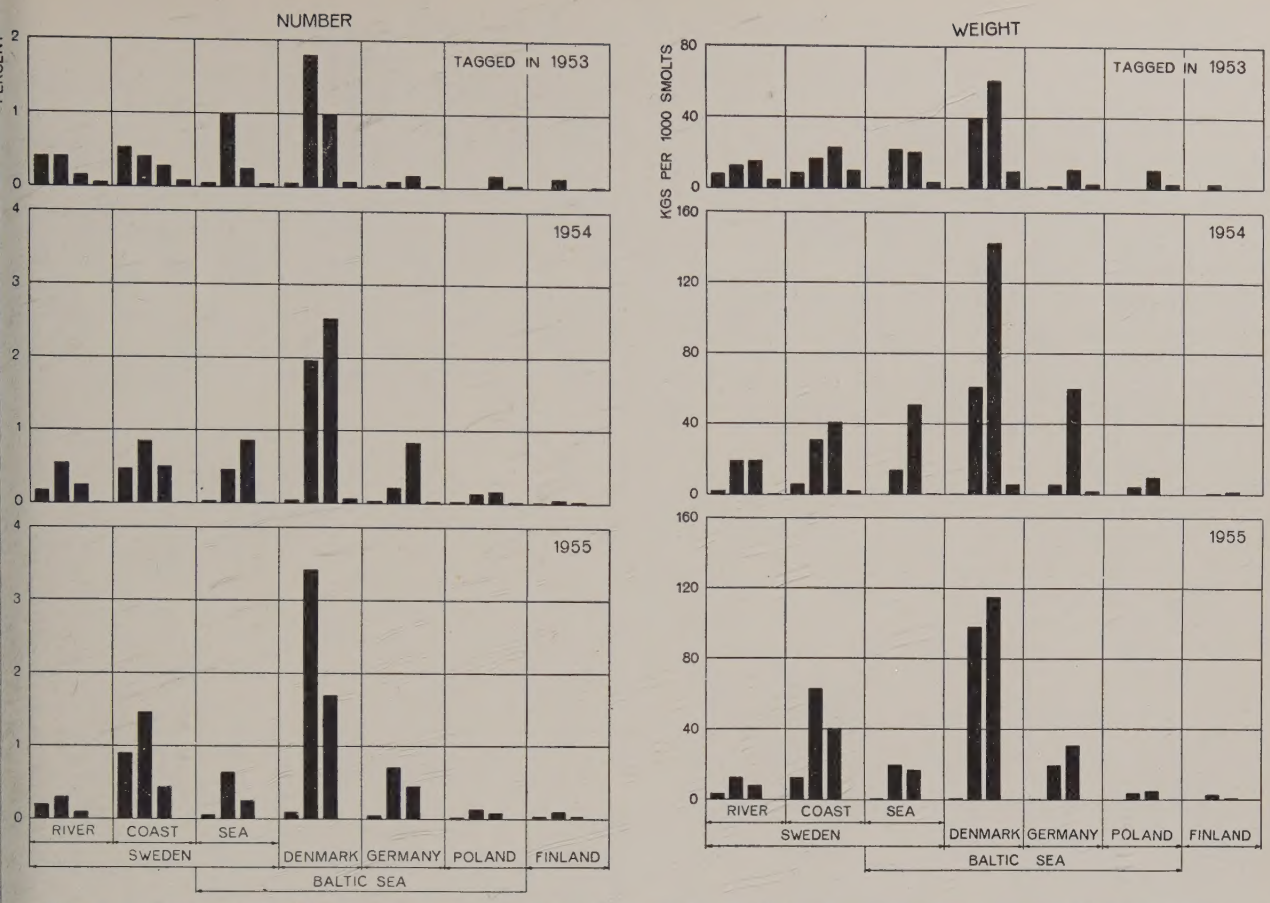

Figure 8. Distribution of the recaptures, by numbers (%) and weight (kg), of tagged salmon among fishermen from different nations. Each column represents the catch in one year.

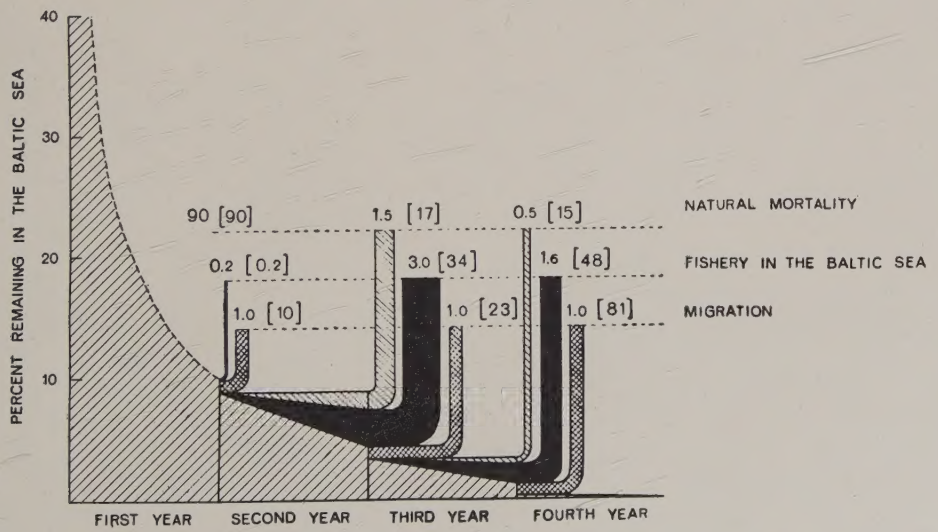

Figure 9.

portion that mortality in the first year should be 90 % and later on, only 2 %. But if we, for instance, assume that mortality in the first year is only 80 %, this will mean that the losses afterwards from natural mortality are twice or three times as much as the losses caused by fishing. In that case, all regulation of the salmon fishery in the Baltic would be both unnecessary and without benefit, and we can hardly believe that.

Such a high initial mortality seems to indicate that the most important enemies are not necessarily large animals, such as seals and porpoises, but very likely small animals, such as birds and fishes. Some of our tagging experiments have shown that smolts of a size between 20 and 25 cm in length give a much higher proportion of recaptures than smolts of about 14 cm in some cases up to 30 % or 40 %, instead of 5 % to 10 %. This seems to be in favour of a high mortality during the very earliest stages of sea life.

Very slight fluctuations in this initial mortality may cause considerable fluctuations in the surviving salmon stock. From a practical point of view it also means that an improvement in the condition of the smolts, released from the hatcheries, may have a very favourable influence on the yield. We may also get better results from our efforts, by releasing larger smolts or by releasing them as far as possible out of reach of predators concentrated in the area of the river mouth.